A CATALOGUE OF CRUDE OIL AND OIL PRODUCT PROPERTIES

by

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ABSTRACT

This report presents available data on the properties of crude oils and oil products. Data are grouped into two sections: comprehensive and standard assay.

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1.0 INTRODUCTION

Many data relating to the properties of spilled crude oils and oil products are compiled in this report. Since data from many sources are involved, differences in reported data may be due to compositional variation of oil samples or inherent difference in measurement methods.

Data are grouped into two sections: comprehensive data and standard assay data. The comprehensive data section contains physical and chemical, spill behavioural and toxicity properties. The effect of temperature and weathering on these properties are also provided when possible. The standard assay data section contains any available data which may be useful.

Two abbreviations are used in the data sections: N/A (not applicable) and N/M (not measurable).

2.0 DESCRIPTION OF COMPREHENSIVE DATA

2.1 General

In the comprehensive data section, data listings are arranged in alphabetical order according to oil type.

For each crude oil or oil product, available information on chemical and physical properties, behavioural properties, toxicity, and other relevant information are provided. Equations are reported to describe the effect of temperature and weathering on many properties. Note that these equations are applicable to the temperature and weathering range of the original data only.

When specific data were not available on some properties, blank spaces are allocated in its place in the data sheets. They are presented as such in order to permit easy updating on an ongoing basis.

The degree of weathering of the oils are represented by volume or weight percent loss of the original oil sample. Artificial weathering of oil samples may be performed by gas stripping, where the volume of oil sample is stripped by a stream of compressed air until the desired amount of weathering is achieved (Mackay 1982a, Mackay 1983b).

2.2 Type

The type of crude oils and oil products and other relevant information are provided in this section.

2.3 Colour

The observed colour of the oils is provided.

2.4 API Gravity

API gravity is defined as:

$$\text{API Gravity} = \frac{141.5}{\text{Sp. Gr. (60/60 F)}} - 131.5 \qquad (2.1)$$

where Sp. Gr. (60/60 F) is the oil density at 15.6 deg C (60 deg F) divided by the density of water at 15.6 deg C (60 deg F).

2.5 Density

Density is defined as the mass of a unit volume of oil at a specified temperature and has the units g/ml (Speight 1980). Density was measured by determining the weight of an oil sample in a 5 or 10 ml pycnometer of accurately known volume at a specific temperature (ASTM D 1480). The density of crude oils and oil products is dependent on temperature and degree of weathering or evaporation.

A convenient equation to express density at different temperatures and degree of weathering (Mackay 1983a) is:

$$DEN = DEN0 + C1\ F - C2\ (T - Ts) \tag{2.2}$$

where: DEN is density at T and F (g/ml)
DEN0 is density of fresh oil at Ts (g/ml)
C1,C2 are constants
F is fraction of oil weathered
T is temperature of oil (deg C)
Ts is standard temperature (deg C)

2.6 Viscosity

Viscosity is a measure of the flow resistance of a fluid. It is defined as:

$$\text{Dynamic Viscosity} = \frac{\text{Shear Stress}}{\text{Rate of Shear}} \tag{2.3}$$

The units for dynamic viscosity are mPa.s (or centipoise). Dynamic viscosity is measured by timing the flow of a volume of oil, under gravity, through a capillary at a test temperature (ASTM D 445). For a more viscous oil or oil that is non-Newtonian, viscosity can be measured by a Brookfield viscometer, which rotates a cylinder in the fluid and measures the torque necessary to induce rotation (Perry 1973).

Kinematic viscosity, which is defined below, is also widely used:

$$\text{Kinematic Viscosity} = \frac{\text{Dynamic Viscosity}}{\text{Density}} \tag{2.4}$$

The unit for kinematic viscosity is mm^2/sec (or centistoke).

Viscosity is dependent on temperature and degree of weathering (Mackay 1983a) as follows:

$$VISC = VISCO \exp(C3\ F) \exp(C4\ (1/TK - 1/TKs)) \quad (2.5)$$

where: VISC is viscosity at F and TK (mPa.s)
VISCO is viscosity of fresh oil at TKs (mPa.s)
C3,C4 are constants
F is fraction of oil weathered
TK is temperature of oil (Kelvin, TK = deg C + 273)
TKs is standard temperature (Kelvin)

2.7 Interfacial Tensions

Interfacial tension is the force of attraction between the molecules at the interface of a liquid (Fingas 1979). An indication of both the oil-air and oil-water interfacial tension is essential for calculating spreading rates and the likely extent to which the oil will form oil-in-water and water-in-oil emulsions (Mackay 1983a).

Interfacial tensions are commonly measured by the de Nouy ring technique in which the force required to draw a platinum-iridium ring through the interface is measured (Mackay 1983a, ASTM D 971). The units for interfacial tension are mN/m (or dynes/cm).

The effect of weathering on interfacial tensions (Mackay 1983a) is shown below:

$$SOA = SOAO + C5\ F \quad (2.6)$$

where: SOA is oil-air interfacial tension at F (mN/m)
SOAO is oil-air interfacial tension of fresh oil (mN/m)
C5 is a constant
F is fraction of oil weathered

$$SOW = SOWO + C6\ F \quad (2.7)$$

where: SOW is oil-water interfacial tension at F (mN/m)
SOWO is oil-water interfacial tension of fresh oil (mN/m)
C6 is a constant

2.8 Pour Point

Pour point is the lowest temperature, expressed as a multiple of 3 degree C, at which the oil sample is observed to flow when cooled under prescribed conditions (ASTM D 97). After preliminary heating, the oil sample in a test jar is cooled at a specified rate by immersion into cooling baths kept at different temperatures. The lowest temperature at which movement of oil is observed in the test jar is recorded as the pour point (in degree C).

Pour point as affected by weathering (Mackay 1983a) can be expressed as follows:

$$PP = PPO\ (1 + C7\ F) \qquad (2.8)$$

where: PP is pour point (deg C)
PPO is pour point of fresh oil (deg C)
C7 is a constant
F is fraction of oil weathered

2.9 Flash Point

Flash point is the lowest temperature, corrected to one atmosphere (101.3 kPa), at which vapours above an oil sample ignite in air when exposed to a flame under specified test conditions. Flash point can be measured by Cleveland Open-cup, Tag Closed and Open-cup, Pensky-Martens Closed, and Setaflash Closed Testers. Generally, the oil sample in the open cup type testers is heated in a open vessel to a selected temperature. A test flame is introduced over the surface of the oil to determine whether the flash point has been reached. If not, the temperature of the oil sample is raised at a specified rate and the process repeated. In the closed cup testers, the oil sample is enclosed until a test flame is applied at a specified temperature. If flash point is not reached, the oil sample is covered, oil temperature is increased at a specified rate and the process repeated. Loss of volatiles from the oil samples is reduced in this procedure (TSB 1984, ASTM D 92, ASTM D 56, ASTM D 1310, ASTM D 93, ASTM D 3278, Lance 1979).

In the data section, flash points determined by open cup and closed cup type testers are designated by "(O.C.)" and "(C.C.)", respectively. No designation is provided if the testing method is not known.

The effect of weathering on flash point (Mackay 1983a) is:

$$L = LO\ (1 + C8\ F) \qquad (2.9)$$

where: L is flash point at F (deg C)
LO is flash point of fresh oil (deg C)
C8 is a constant
F is fraction of oil weathered

2.10 Vapour Pressure

Vapour pressure is the pressure that an oil exerts on its surroundings. Its units are kPa corrected to one atmosphere (101.3 kPa). Vapour pressure can be measured by Reid, dynamic, static, isoteniscopic, vapour pressure balance and gas saturation methods. The Reid vapour pressure at 37.8 deg C (100 deg F) is reported. It is measured by saturating a known volume of oil in an air chamber of known volume and measuring the equilibrium pressure which is then corrected to one atmosphere (101.3 kPa) (ASTM D 323, ASTM D 2551, ASTM D 2879, OECD 1981, TSB 1984, USEPA 1982).

2.11 ASTM Distillation

ASTM distillation provides volatility and relative component distribution characteristics of crude oils and oil products. A 100 ml sample is placed in a standard distillation apparatus and heated at a specified rate. Vapour from the oil sample is condensed and collected in graduated cylinders. Vapour temperatures (corrected to one atmosphere or 101.3 kPa) and condensate volumes are recorded. The following definitions are useful:

- Initial boiling point is the temperature at the instant that the first drop of condensate falls from the lower end of the condenser tube.

- End point or final boiling point is the maximum temperature obtained during the test. This usually occurs after the evaporation of all liquid from the bottom of the flask.

- Percent recovered is the volume in millilitres of condensate observed in the receiving graduated cylinder, in connection with a simultaneous thermometer reading.

For better distillate separation of crude oils, a fractionating column can be added (ASTM D 86, ASTM D 285, ASTM E 133).

2.12 Emulsion Formation Tendency and Stability

Water-in-oil emulsion (or "chocolate mousse") is a stable emulsification of small droplets of water incorporated in oil. Oil spilled on a water surface may form stable water-in-oil emulsion which can have very different characteristics than the parent crude oil.

The tendency for a crude oil to form a stable water-in-oil emulsion is measured (Mackay 1982a, Mackay 1984a) as follows:

- Rotate oil and artificial seawater (oil to seawater volume ratio of 1 to 9) in a stoppered Fleaker for one hour at 65 rpm followed by a half hour resting period.
- Measure, visually, fraction of oil that is in the emulsion (f).
- Repeat rotation, resting and measurements three times.
- Obtain f initial by extrapolation.

The following criteria were used to classify the tendency of a crude oil to form stable emulsion (Mackay 1982a):

Range of f initial	Emulsion Formation Tendency
0.0 to 0.25	Not likely
0.25 to 0.75	Fairly likely
0.75 to 1.0	Very likely

The stability of a water-in-oil emulsion is obtained by allowing the emulsion to rest for 24 hours in the stoppered Fleaker in an upright postion, and measuring the fraction of oil in the emulsion (f final) visually. The stability of the water-in-oil emulsion is classified (Mackay 1982a) as follows:

Range of f final	Emulsion Stability
0.0 to 0.25	Unstable
0.25 to 0.75	Fairly stable
0.75 to 1.0	Very stable

The calculated water content of stable water-in-oil emulsions is also provided. The maximum water content for a stable emulsion is 90 percent by volume as specified by the experimental procedure.

2.13 Weathering of Crude Oils

Weathering of crude oils in the environment can be estimated from a modified ASTM distillation experiment. A sample of crude oil is distilled in standard glassware using a hot plate/stirrer. The glassware is insulated and distillate is collected in a graduated cylinder immersed in an ice/water bath. The oil temperature is monitored instead of the temperature of the saturated vapour as in the standard ASTM distillation method. From the gradient and the initial boiling temperature of the distillation curve (a plot of oil temperature versus fraction of oil condensed), the fraction of oil weathered under environmental conditions can be estimated. This estimation method is not very accurate for prolonged weathering of oil spills. At low environmental temperatures, some oils have a tendency to form a surface layer that may reduce the evaporation rate. This estimation method does not apply to refined petroleum products (Mackay 1982a, Mackay 1983b, ASTM D 86).

The calculation procedure is as follows:

(1) Obtain or estimate the following:

- average environment temperature (TK) in Kelvin (Kelvin = deg C + 273)
- volume of the oil spill (V) in cu m,
- area of the oil spill (A) in sq m,
- duration of oil spill (t) in seconds
- average wind speed in m/s,

(2) Calculate mass transfer coefficient (K) in m/s:

$$K = 0.002\,(\text{wind speed})^{0.78} \qquad (2.10)$$

(3) Calculate evaporative exposure (O):

$$O = K A t / V \qquad (2.11)$$

O can also be calculated if the thickness (in m) of the oil slick can be estimated:

$$O = K t / \text{thickness} \qquad (2.12)$$

(4) Calculate fraction (by volume) of oil weathered:

$$Fv = \frac{\ln(1 + 10.3\ TG\ O\ \exp(6.3 - 10.3\ TO/TK) / TK)}{(10.3\ TG / TK)} \qquad (2.13)$$

where: Fv is fraction of oil weathered by volume
ln is natural log (or take log base 10 and multiply by 2.3)
TO is initial boiling point of modified ASTM distillation curve (Kelvin)
TG is gradient of modified ASTM distillation curve (Kelvin)
exp is exponential base e

2.14 Spreading

The spreading coefficient is an indication of the tendency for crude oils and oil products to spread. The spreading coefficient is defined as:

$$\text{Spreading Coefficient} = SWA - SOA - SOW \qquad (2.14)$$

where: SWA is water-air interfacial tension (mN/m)
SOA is oil-air interfacial tension (mN/m)
SOW is oil-water interfacial tension (mN/m)

Spreading to a thin slick will occure if the spreading coefficient of an oil is greater than zero, and the higher the spreading coefficient the faster the spreading will occur.

2.15 Fire Point

Fire point is the lowest temperature, corrected to atmospheric pressure (101.3 kPa), that the application of a test flame to the oil sample surface causes the vapour of the oil to ignite and burn for at least five seconds. It is measured by Cleveland Open Cup and modified Pensky-Martens Apparatus. The procedure is similar to the procedure for flash point determination (ASTM D 92, IP 35).

The effect on fire point due to weathering (Mackay 1983a) is:

$$I = I0\ (1 + C9\ F) \qquad (2.15)$$

where: I is fire point at F (deg C)
IO is fire point of fresh oil (deg C)
C9 is a constant
F is fraction of oil weathered

2.16 Solubility

Solubility of crude oils and oil products can be measured by bringing the oil sample to equilibrium with deionized or artificial seawater at a test temperature and analysing the water phase by either gas stripping or liquid extraction. Solubility can be assumed to be independent of temperature and is significantly reduced by weathering (Mackay 1983a) as follows:

$$S = S0\ \exp\ (-C10\ F) \qquad (2.16)$$

where: S is solubility at F (mg/L)
SO is solubility of fresh oil (mg/L)
C10 is a constant
F is fraction of oil weathered

2.17 Paraffin, Olefin, Aromatic, Wax and Asphaltene Content

Paraffins (alkanes) are saturated hydrocarbons that are relatively stable. They do not react with cold fuming sulfuric acid and are not adsorbed on silica gel under specified conditions (Nelson 1958, ASTM 1979).

Olefins (alkenes) are unsaturated straight chain hydrocarbons and are more reactive than paraffins. They react with and dissolve in sulfuric acid (Nelson 1958).

Aromatics are characterized by rings containing 6 carbon atoms. They are considered to be the most toxic hydrocarbons found in oils (Fingas 1979).

Waxes generally consist of long-chain hydrocarbons and probably consist of straight or branched chain paraffins (Nelson 1958, Fingas 1979).

Asphaltenes consist of polynuclear aromatic clusters with relatively small alkane side chains. They are insoluble in alkane solvents such as heptane (Mackay 1984a).

The paraffin, olefin and aromatic content of a crude oil can be determined by high performance liquid chromatography. The wax content can be determined by adding methyl ethyl ketone to the oil sample and chilling the mixture to -10 deg C. Waxes are precipitated and collected by filtration. Asphaltene content is obtained by precipitation and filtration using hexane (Mackay 1982a).

Wax and asphaltene content increases with increasing weathering (Mackay 1983a) as follows:

$$WAX = WAXO / (1 - F) \tag{2.17}$$

where: WAX is wax content at F (mass fraction)
WAXO is wax content of fresh oil (mass fraction)
F is fraction of oil weathered

$$ASPH = ASPHO / (1 - F) \tag{2.18}$$

where: ASPH is asphaltene content at F (mass fraction)
ASPHO is asphaltene content of fresh oil (mass fraction)

2.18 Carbon Residue, Sulphur, Hydrogen Sulphide and Metal Content

Carbon residue is the carbonaceous residue formed after evaporation and pyrolysis of a petroleum product. Carbon residue can be determined by the Conradson or the Ramsbottom methods. The Conradson carbon residue method is more applicable to crude oils and heavy fuel oils. It involves destructive distillation of a weighed oil sample in a crucible. The oil sample is further heated severely for a fixed period of time while the distillation residue undergoes cracking and coking. The Conradson carbon residue is the weight percent of the carbonaceous residue left in the crucible (ASTM D 189, ASTM D 524).

Sulphur content is the weight percent of total sulphur in crude oils or oil products. It can be determined by burning an oil sample in a stream of oxygen at a sufficiently high temperature to convert about 97 percent of the sulphur to sulphur dioxide. The combustion products then flow into an absorber containing an acid solution of potassium iodide and starch indicator. As combustion proceeds, more iodate is added as indicated by the colour of the acid solution. The amount of standard iodate consumed during the combustion is converted to sulphur content of the oil sample (ASTM D 1552).

Hydrogen sulphide content for natural gas and liquefied petroleum gases can be determined by cadmium sulphate-iodometric titration and lead acetate methods, respectively (ASTM D 2385, ASTM D 2420).

The content of many metals in crude oils and oil products can be determined by atomic absorption (ASTM D 2788, Skoog 1976).

2.19 Chemical Dispersibility

The comparative chemical dispersibility is an indication of the ability to disperse an oil slick chemically in the open sea. The Mackay-Nadeau-Steelman (MNS) apparatus was used. This method simulates wind and wave action in a circular tank, where oil and pre-determined amount of dispersant is added in a reproducable manner. Water sample is taken from a fixed location in the tank and is analyzed for oil content. The test is repeated several times with varying amount of chemical dispersant, and the oil to dispersant ratio (by volume) at 50 percent (by volume) oil dispersion is estimated. A particular oil with an oil to dispersant ratio below 10 (i.e. the oil required more than 1 mL of disperdsant to disperse 50 percent of a 10 mL oil slick in this test) is considered not likely to be dispersed in the open sea. Conversely the higher the oil to disperant ratio, the easier the oil can be dispersed.

In this report, chemical dispersibility tests were conducted at a medium sea state (wind speed of 6 to 14 m/s) and production grade Corexit 9527 was used.

2.20 Toxicity

Toxicity values are given as:

- LC50: the estimated concentration of oil which will cause death to 50 percent of the test population in a specified time after exposure.

- LC100: the estimated concentration of oil which will cause death to 100 percent of the test population in a specified time after exposure.

- Median Tolerance Limit (TLm): the concentration at which 50 percent of the test population will show abnormal behaviour.

3.0 DESCRIPTION OF STANDARD ASSAY DATA

The standard assay data section contains the following information:

- API Gravity
- Colour
- Viscosity
- ASTM Distillation
- Sulphur Content
- Nitrogen Content
- Volume Percent at Cut Temperatures

Volume percent at cut temperatures provide the volume percent of naphtha (C5 to 190 deg C), kerosine (190 to 277 deg C), distillate (277 to 343 deg C), gas oil (343 to 565 deg C) and residue (above 565 deg C) in the crude oil.

Other data relevant to environmental concerns are also included.

4.0 REFERENCES

Aalund 1983
Aalund, L. R., "Guide to Export Crudes for the '80s - Part 13, Assay Series Concludes with Index, U.S. Streams", Oil & Gas Journal, Dec. 19, Pg 71-74 (1983).

Aalund 1983a
Aalund, L. R., "Guide to Export Crudes for the '80s - Part 12, Important North American Crudes", Oil & Gas Journal, Dec. 12, Pg 120-125 (1983).

API 1981
Anonymous, "API-EPA Sample Analysis of Standard Reference Oils", American Petroleum Institute and Environmental Protection Agency, reference number P. O. #71271 (1981).

ASTM 1979
American Society for Testing and Materials, "Compilation of ASTM Standard Definitions", 4th edition, ASTM Committee on Terminology, Publication No. PCN 03-001079-42 (1979).

ASTM D 56
American Society for Testing and Materials, "ASTM D 56, Standard Test Method for Flash Point by Tag Closed Tester", Annual Books of ASTM Standards, Part 23 (1980).

ASTM D 86
American Society for Testing and Materials, "ASTM D 86, Standard Methods for Distillation of Petroleum Products", ASTM Annual Books of Standards, Part 23 (1980).

ASTM D 92
American Society for Testing and Materials, "ASTM D 92, Standard Test Method for Flash and Fire Points by Cleveland Open-cup", Annual Books of ASTM Standards, Part 23 (1980).

ASTM D 93
American Society for Testing and Materials, "ASTM D 93, Standard Test Methods for Flash Point by Pensky-Martens Closed Tester", Annual Books of ASTM Standards, Part 23 (1980).

ASTM D 97
American Society for Testing and Materials, "ASTM D 97, Standard Method of Testing for Pour Point of Petroleum Oils", Annual Books of ASTM Standards, Part 23 (1980).

ASTM D 189
American Society for Testing and Materials, "ASTM D 189, Standard Test Method for Conradson Carbon Residue of Petroleum Products", Annual Books of ASTM Standards, Part 23 (1980).

ASTM D 285
American Society for Testing and Materials, "ASTM D 285, Standard Method for Distillation of Crude Petroleum", Annual Books of ASTM Standards, Part 23 (1980).

ASTM D 323
American Society for Testing and Materials, "ASTM D 323, Standard Test Method for Vapour Pressure of Petroleum Products (Reid Method), Annual Books of ASTM Standards, Part 23 (1980).

ASTM D 396
American Society for Testing and Materials, "ASTM D 396, Standard Specification for Fuel Oils", Annual Books of ASTM Standards, Part 23 (1980).

ASTM D 439
American Society for Testing and Materials, "ASTM D 439, Standard Specification for Automotive Gasoline", Annual Books of ASTM Standards, Part 23 (1980).

ASTM D 445
American Society for Testing and Materials, "ASTM D 445, Standard Test Methods for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)", Annual Books of ASTM Standards, Part 23 (1980).

ASTM D 524
American Society for Testing and Materials, "ASTM D 524, Standard Test Method for Ramsbottom Carbon Residue of Petroleum Products", Annual Books of ASTM Standards, Part 23 (1980).

ASTM D 971
American Society for Testing and Materials, "ASTM D 971, Standard Test Method for Interfacial Tension of Oil against Water by the Ring Method", Annual Books of ASTM Standards, Part 23 (1980).

ASTM D 1310
American Society for Testing and Materials, "ASTM D 1310, Standard Test Method for Flash Point of Liquids by Tag Open-cup Apparatus", Annual Books of ASTM Standards, Part 23 (1980).

ASTM D 1480
American Society for Testing and Materials, "ASTM D 1480, Standard Test Method for Density and Relative Density (Specific Gravity) of Viscous Materials by Binghan Pycnometer", Annual Books of ASTM Standards, Part 23 (1980).

ASTM D 1552
American Society for Testing and Materials, "ASTM D 1552, Standard Test Method for Sulphur in Petroleum Products (High-temperature Method)", Annual Books of ASTM Standards, Part 23 (1980).

ASTM D 2385
American Society for Testing and Materials, "ASTM D 2385, Standard Test Method for Hydrogen Sulphide and Mercaptan Sulphur in Natural Gas (Cadmium Sulphate - Iodometric Titration Method)", Annual Books of ASTM Standards, Part 24 (1980).

ASTM D 2420
American Society for Testing and Materials, "ASTM D 2420, Standard Test Method for Hydrogen Sulphide in Liquefied Petroleum (LP) Gases (Lead Acetate Method)", Annual Books of ASTM Standards, Part 24 (1980).

ASTM D 2551
American Society for Testing and Materials, "ASTM D 2551, Standard Test Methods for Vapour Pressure of Petroleum Products (Micromethod)", Annual Books of ASTM Standards, Part 24 (1980).

ASTM D 2788
American Society for Testing and Materials, "ASTM D 2788, Standard Test Method for Trace Metals in Gas Turbine Fuels (Atomic Absorption Method)", Annual Books of ASTM Standards, Part 24 (1980).

ASTM D 2879
American Society for Testing and Materials, "ASTM D 2879, Standard Test Method for Vapour Pressure-Temperature Relationship and Initial Decomposition Temperature of Liquids by Isoteniscope", Annual Books of ASTM Standards, Part 24 (1980).

ASTM D 3828
American Society for Testing and Materials, "ASTM D 3828, Standard Test Methods for Flash Point by Setaflash Closed Tester", Annual Books of ASTM Standards, Part 25 (1980).

ASTM E 133
American Society for Testing and Materials, "ASTM E 133, Standard Specification for Distillation Equipment", Annual Books of ASTM Standards, Part 24 (1980).

Bland 1967
Bland, W.F. & Davidson, R. L., "Petroleum Processing Handbook", McGraw-Hill, New York (1967).

Bobra 1983
Bobra, A. M., Shiu, W. Y., Mackay, D., "Toxicity of Hydrocarbons and Crude Oils", Proceedings of the Sixth Artic Marine Oilspill Program Technical Seminar (1983).

Cormack 1978
Cormack, D., Nichols, J. A., Lynch, B., "Investigation of Factors Affecting the Fate of North Sea Oils Discharged at Sea, Part 1: Ekofisk Crude Oil July 1975 - February 1978", Warren Spring Laboratory, Report No. LR 273(OP) (1978).

Curl 1977
Curl, H., Jr. & O'Donnell, K., "Chemical and Physical Properties of Refined Petroleum Products", Environmental Research Laboratories, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (1977).

Dome 1984
Private Communication, Dome Petroleum to Environmental Emergency Technology Division, Technical Services Branch, Environmental Protection Service, Environment Canada (1984).

EETD 1984
Experimental data from Environmental Emergencies Technology Division, Technical Services Branch, Environmental Protection Service, Environment Canada (1984).

Engelhardt 1984
Engelhardt, F. R., ed., "Petroleum Effects in the Artic Environment", (in preparation) (1984).

Esso 1983
Private Communication, Esso Resources Canada Limited to Environmental Emergency Technology Division, Technical Services Branch, Environmental Protection Service, Environment Cnanda (1983).

Fingas 1979
Fingas, M.F., Duval, W.S. & Stevenson, G. B., "The Basics of Oil Spill Cleanup", Environmental Emergency Branch, Environmental Protection Service, Environment Canada (1979).

Gulf 1983
Gulf Canada Resources Inc., "East Tarsiut Crude Oil Analysis", Internal Report, File No. 187-80-29 (1983).

HMSO 1976
Her Majesty's Stationery Office, "Accidental Oil Pollution of the Sea", Depatment of the Environment Central Unit on Environmental Pollution, A Report by Officials on Oil Spills and Clean up Measures, Pollution Paper #8 (1976).

Hutcheson 1983
Hutcheson, M. S., Keizer, P. O. & Odense, R., "Chemistry and Toxicity of the Venture Field Condensates", Prepared for Mobil Oil Canada Ltd. (1983).

IP 1980
Institute of Petroleum, "IP 35, Flash Point (Open) and Fire Point by means of the Pensky-Martens Apparatus", IP Standards for Petroleum and its Products, Part 1, Methods for Analysis and Testing, Vol 1 (1980).

Lance 1979
Lance, R.C., Barnard, A.J., Jr & Hooyman, J.E., "Measurement of Flash Points: Apparatus, Methodology, & Applications", Journal of Hazardous Materials, Vol 3, Pg 107-119 (1979).

Lynch 1981
Lynch, B. W. J., "The Fate of Controlled Oil Spills at Sea", Warren Spring Laboratory, Report No. LR 390(OP) (1981).

Mackay 1974
Mackay, D., Charles, M.E. & Phillips, C. R., "The Physical Aspects of Crude Oil Spills on Northern Terrain, for The Environmental-Social Program", Task Force on Northern Oil Development, Report No. 73-42 (Info. Can. Cat. No. R72-9173) (1974).

Mackay 1975
Mackay, D., Charles, M. E. & Phillips, C. R., "The Physical Aspects of Crude Oil Spills On Northhern Terrain (Final Report)", Ministry of Indian and Northern Affairs, INA Pub. No. QS 8060-000-EE-AI (1975).

Mackay 1980a
Mackay, D., Hossain, K. & Shiu, W. Y., "Analysis of Beaufort Sea and Prudhoe Bay Crude Oils", Department of Chemical Engineering and Applied Chemistry, University of Toronto (1980).

Mackay 1980b
Mackay, D. & Szeto, F., "Effectiveness of Oil Spill Dispersants. Development of a Laboratory Method and Results for Selected Commercial Products", Institute for Environmental Studies, University of Toronto, Publication No. EE-16 (1980).

Mackay 1982a
Mackay, D. & Zagorski, W., "Studies of Water-In-Oil Emulsions", Prepared for Research and Development Division, Environmental Emergency Branch, Environmental Impact Control Directorate, Environmental Protection Service, Environment Canada, Publication No. EE-34 (1982).

Mackay 1982b
Mackay, D., Shiu, W. Y., Hossain, K., Stiver. W., McCurdy, D., Paterson, S. & Tebeau, P.A., "Development and Calibration of an Oil Spill Behaviour Model", Prepared for U.S. Coast Guard (1982).

Mackay 1983a
Mackay, D., Stiver, W. & Tebeau, P.A., "Testing for Crude Oils & Petroleum Products for Environmental Purposes", Proceedings for the 1983 Oil Spill Conference at San Antonio, Texas (1983).

Mackay 1983b
Mackay, D., & Stiver, W., "Evaporation Rate of Spills of Hydrocarbons and Petroleum Mixtures", for Environmental Emergencies Technology Division, Technical Services Branch, Environmental Protection Programs Directorate, Environment Canada, Publication EE-49 (1983).

Mackay 1984a
Mackay, D., & Nowak, M., "Formation and Stability of Water-in-Oil Emulsions", for Environmental Emergencies Techology Division, Technical Services Branch, Environmental Protection Programs Directorate, Environmental Protection Service, Environment Canada (in preparation) (1984).

Martin 1977
Martin, S., Kauffman, P. & Welander, P.E., "A Laboratory Study of the Dispersion of Crude Oil within Sea Ice Grown in a Wave Field", 27th Alaska Science Conference Proceedings (1977).

Naval 1977
Anonymous, "Oil Spill Control for Inland Waters and Harbors", Naval Facilities Engineering Comand, Department of the Navy, Report No. NAVFAC P-908 (1977).

Nelson 1958
Nelson, W.L., "Petroleum Refinery Engineering", McGraw-Hill, New York (1958).

OECD 1981
Anonymous, "OECD Guidelines for Testing of Chemicals", the Organization for Economic Co-operation and Development, Paris, France (1981)

OHMTADS 1981
Anonymous, "Oil and Hazardous Materials Technical Assistance Data System", Office of Water Program Operations, Oil and Special Materials Control Division, U.S. EPA (1981).

Pancirov 1974
Pancirov, R.J., "Compositional Data on API Reference Oils Used in Biological Studies: a #2 Fuel Oil, a Bunker C, Kuwait Crude Oil, and South Louisiana Crude Oil", Esso Research and Engineering Company, Report No. AID.1BA.74 (1974).

Perez 1979
Perez, R.H., "Mexico's Export Oil: Its Source and Qualities", Oil and Gas Journal, Vol.77 (8), Pg 89-91 (1979).

Perry 1973
Perry, R.H. & Chilton, C. H., ed., "Chemical Engineers' Handbook", 5th ed., McGraw-Hill, New York (1973).

Ross 1982a
Ross, S.L., Environmental Research Ltd., "The Behaviour and Fate of Gas and Condensate Spills", Prepared for Mobil Oil Canada Limited's Venture Gas Field Development (1982).

Ross 1984
Ross, S.L., Environmental Research Ltd., "Hibernia Oil Spills and their Control", Prepared for Mobil Oil Canada Ltd. (1984).

Skoog 1976
Skoog, D.A. & West, D.M., "Fundamentals of Analytical Chemistry", 3rd ed, Holt, Rinehart and Winston (1976).

Speight 1980
Speight, J.G., "The Chemistry and Technology of Petroleum", Marcel Dekker, Inc., New York (1980).

Stiver 1982
Stiver, W., "Studies of Crude Oil Evaporation", Bachelor of Applied Science Thesis, Department of Chemical Engineering and Applied Chemistry, University of Toronto (1982).

TSB 1984
Anonymous, "Manual for Spills of Hazardous Materials", Technical Services Branch, Environmental Protection Service, Environmental Canada, Cat No. Em40-320/1984E (1984).

Twardus 1980
Twardus, E. M., "A Study to Evaluate The Combustibility and Other Physical and Chemical Properties Of Aged Oils And Emulsions", Prepared for Research and Development Division, Environmental Emergency Branch, Environmental Impact Control Directorate, Environmental Protection Service, Environment Canada, Publication No. EE-5 (1980).

USCG 1971
Glaeser, J.L. & Vance, G.P., "A Study of The Behavior of Oil Spills in The Arctic", Office of Research and Development, U.S. Coast Guard (1971).

USCG 1972
McMinn, T. J., "Crude Oil Behavior on Arctic Winter", Ice, Environmental and Transportation Technology Division, U.S. Coast Guard (1972).

USEPA 1982
Anonymous, "Chemical Fate Test Guidelines", Office of Toxic Substances, Office of Pesticides and Toxic Substances, U.S. Environmental Protection Agency, Publication No. PB82-233008 (1982).

Yuen 1970
Yuen, K., "Report of The Task Force - Operation Oil (Clean-Up of The Arrow Oil Spill in Chedabucto Bay)", Vol. II, Minister of Transport, Info. Can. Cat. No. T22-2470/2 (1970).

5.0 DATA LISTING

5.1 Comprehensive Data

- Adgo Crude Oil
- Automotive Diesel
- Automotive Gasoline
- Bunker C or Fuel Oil Number 6
- Fuel Oil Number 2
- Hibernia Crude Oil
- Isthmus Blend Crude Oil, Mexico
- Lago Medio Crude Oil, Venezuela
- Norman Wells Crude Oil
- Prudhoe Bay Crude Oil
- Sable Island Condensate
- Sour Blend Crude Oil
- Sweet Blend Crude Oil
- Sweet Mixed Blend Crude Oil
- Tarsiut Crude Oil
- Transmountain Blend Crude Oil

COMPREHENSIVE DATA - ADGO CRUDE OIL
PAGE 1

1.0 TYPE: ADGO CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml):

DEN = 0.959 - 0.00035 T
where: DEN is density of oil at T (g/ml)
T is oil temperature (deg C)

TEMP (DEG C)	WEATHERING (VOL %) 0	2.6	4	12
0	0.959 (EETD 84)	0.962 (EETD 84)		
15	0.953 (EETD 84)	0.960 (EETD 84)		
20	0.9520 (ESSO 83)		0.9526 (ESSO 83)	0.9546 (ESSO 83)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	165.0(EETD 84)		
15	61.6(EETD 84)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (%) 0	4	12
-10	661.3(ESSO 83)	724.5(ESSO 83)	1302(ESSO 83)
0	172.1(EETD 84) 233.9(ESSO 83)	263.6(ESSO 83)	413.8(ESSO 83)
15	64.6(EETD 84) 73.01(ESSO 83)	79.08(ESSO 83)	103.2(ESSO 83)
25	39.83(ESSO 83)	42.72(ESSO 83)	53.58(ESSO 83

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (VOL %) 0	2.6	..
0	33.3(EETD 84)	31.5(EETD 84)	
15	32.0(EETD 84)	30.6(EETD 84)	

6.2 OIL-SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (VOL %) 0	2.6	..
0	5.80(EETD 84)	14.2(EETD 84)	
15	6.9(EETD 84)		

6.3 OIL-WATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	23.5(EETD 84)		
15	24.9(EETD 84)		

COMPREHENSIVE DATA - ADGO CRUDE OIL

7.0 POUR POINT (DEG C):

WEATHERING (%)	POUR POINT (DEG C)
0	-26(ESSO 83)
4	-26(ESSO 83)
12	-26(ESSO 83)

8.0 FLASH POINT (DEG C):

WEATHERING (%)	FLASH POINT (DEG C)
0	95(ESSO 83)
4	94(ESSO 83)
12	126(ESSO 83)

9.0 VAPOUR PRESSURE (kPa): NOT MEASURABLE(EETD 84)

10.0 ASTM DISTILLATION DATA (DEG C):

	WEATHERING (%)		
VOLUME PERCENT	0	4	12
INITIAL	159(ESSO 83)	170(ESSO 83)	205(ESSO 83)
50	329(ESSO 83)	326(ESSO 83)	348(ESSO 83)
FINAL	535(ESSO 83)	542(ESSO 83)	538(ESSO 83)
FINAL VOL CONT'D.	93 %(ESSO 83)	96 %(ESSO 83)	87 %(ESSO 83)

11.0 EMULSION FORMATION TENDENCY & STABILITY:

11.1 EMULSION FORMATION TENDENCY:

	WEATHERING (VOL %)		
TEMP (DEG C)	0	2.6	..
0	0.61(EETD 84)	0.72(EETD 84)	

11.2 EMULSION STABILITY:

TEMP (DEG C)	WEATHERING (VOL %) 0	2.6	..
0	0.95(EETD 84)	0.96(EETD 84)	

11.3 WATER CONTENT OF STABLE EMULSION (VOL %):

TEMP (DEG C)	WEATHERING (VOL %) 0	2.6	..
0	71.5(EETD 84)	73.8(EETD 84)	

12.0 WEATHERING:

$$Fv = \frac{\ln(1 + 2012.6\ \theta\ \exp(6.3 - 5675.3/TK)/TK)}{(2012.6/TK)}$$

where: Fv is fraction of oil weathered by volume
ln is natural log
θ is evaporation exposure
exp is exponential base e
TK is environmental temperature
(Kelvin, K = deg C + 273) (EETD 84)

13.0 SPREADING COEFFICIENT ON SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (VOL %) 0	2.6	..
0	32.07(EETD 84)	25.5(EETD 84)	
15	30.25(EETD 84)		

14.0 OTHERS:

14.1 FIRE POINT (DEG C):

WEATHERING (%)	FIRE POINT (DEG C)
0	116(ESSO 83)
4	123(ESSO 83)
12	129(ESSO 83)

1.0 TYPE: AUTOMOTIVE DIESEL.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml):

TEMP (DEG C)		WEATHERING (%)	
	0	..	..
0	0.838(EETD 84)		
15	0.827(EETD 84) 0.85(FINGAS 79)		

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)		WEATHERING (%)	
	0	..	..
38	12.8(FINGAS 79)		

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm):

TEMP (DEG C)		WEATHERING (%)	
	0	..	..
0	27.7(EETD 84)		
15	26.0(EETD 84)		

6.2 OIL-SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)		WEATHERING (%)	
	0	..	..
0	24.8(EETD 84)		
15	30.3(EETD 84)		

COMPREHENSIVE DATA - AUTOMOTIVE DIESEL
PAGE 2

7.0 POUR POINT (DEG C): -20(FINGAS 79)

8.0 FLASH POINT (DEG C): 55(FINGAS 79)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

11.0 EMULSION FORMATION TENDENCY & STABILITY:

12.0 WEATHERING:

13.0 SPREADING COEFFICIENT ON SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	18.7(EETD 84)		
15	12.9(EETD 84)		

14.0 OTHERS:

14.1 INITIAL BOILING POINT (DEG C): 180 TO 360(FINGAS 79)

COMPREHENSIVE DATA - AUTOMOTIVE GASOLINE
PAGE 1

1.0 TYPE: AUTOMOTIVE GASOLINE (NON-LEADED). TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 60 AT 15 DEG C(FINGAS 79)

4.0 DENSITY (g/ml):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	0.746(EETD 84)		
15	0.729(EETD 84) 0.65 TO 0.75(FINGAS 79)		

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
38	2.6 TO 7.5(FINGAS 79)		

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	20.9(EETD 84)		
15	19.8(EETD 84)		

6.2 OIL-SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	19.8(EETD 84)		
15	20.3(EETD 84)		

7.0 POUR POINT (DEG C): N/A(FINGAS 79)

8.0 FLASH POINT (DEG C):

WEATHERING (%)	TEMP (DEG C)
0	-43(OHMTADS 81) -40(FINGAS 79)

9.0 VAPOUR PRESSURE (kPa): 62 TO 103(ASTM D 439)

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
10	50 TO 70(ASTM D 439)
50	77 TO 121(ASTM D 439)
90	195 TO 190(ASTM D 439)
END POINT	225(ASTM D 439)
RESIDUE	2% MAX(ASTM D 439)

11.0 EMULSION FORMATION TENDENCY & STABILITY:

12.0 WEATHERING:

13.0 SPREADING COEFFICIENT ON SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	30.5(EETD 84)		
15	29.1(EETD 84)		

14.0 OTHERS:

14.1 LEAD CONTENT (g/L): 0.013 MAX(ASTM D 439)

14.2 FLAMMABILITY: QUITE FLAMMABLE, COMBUSTION PROBABLE
(OHMTADS 81)

14.3 AUTO-IGNITION TEMPERATURE: 280(OHMTADS 81),
257(CURL 77)

14.4 EXPLOSION LIMITS OF VAPOUR IN AIR:
UPPER: 7.6 PERCENT(CURL 77)
LOWER: 1.4 PERCENT(CURL 77)

14.5 BOILING POINT (DEG C): 38(OHMTADS 81)

14.6 ODOUR THRESHOLD(PPM):
UPPER: 0.01(OHMTADS 81)
LOWER: 0.005(OHMTADS 81)

14.7 INITIAL BOILING POINT (DEG C): 30 TO 200(FINGAS 79)

14.8 SULPHUR (WT %): 0.10 MAX(ASTM D 439)

COMPREHENSIVE DATA - BUNKER C OR FUEL OIL NO. 6

1.0 TYPE: BUNKER C FUEL OIL OR FUEL OIL NUMBER 6. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 14.1(API 81), 10 AT 15 C(FINGAS 79), 7.3(PANCIROV 74), 15.5(YUEN 70)

4.0 DENSITY(g/ml):

DEN = 0.983 - 0.00073 T
where: DEN is density of fresh oil at T (g/ml)
T is oil temperature (deg C)

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	0.986(EETD 84) 0.980(MACKAY 82A) 0.969 TO 0.981(CURL 77)		
5	0.976(MACKAY 82A)		
10	0.973(MACKAY 82A) 0.963 TO 0.975(CURL 77)		
15	0.974(EETD 84) 0.969(MACKAY 82A) 0.98(FINGAS 79)		
15.6	0.9710(API 81) 0.963(YUEN 70) 0.959 TO 0.972(CURL 77)		
20	0.966(MACKAY 82A) 0.956 TO 0.970(CURL 77)		
25	0.964(MACKAY 82A)		
30	0.950 TO 0.964(CURL 77)		

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	7.35*10**7(TWARDUS 80)		
10	2.87*10**7(TWARDUS 80)		
20	5.98*10**6(TWARDUS 80)		
25	3180(MACKAY 82A)		
38	294 TO 2940(FINGAS 79)		
50	545(YUEN 70)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
10	>1000(CURL 77)		
20	>500(CURL 77)		
40	>130(CURL 77)		
55	90 TO 2000(CURL 77)		
60	65 TO 1000(CURL 77)		
70	65 TO 360(CURL 77)		
80	65 TO 180(CURL 77)		

NOTE: DATA OBTAINED FROM A GRAPH

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm): 27 @ ROOM TEMP (TWARDUS 80)

6.2 OIL-WATER (mN/m or dynes/cm): 39.82 @ ROOM TEMP (TWARDUS 80)

7.0 POUR POINT (DEG C):

WEATHERING (%)	POUR POINT (DEG C)
0	6(MACKAY 82A) 7(TWARDUS 80) 2(FINGAS 79) <16(CURL 77) -1(YUEN 70)

8.0 FLASH POINT (DEG C):

WEATHERING (%)	FLASH POINT (DEG C)
0	>110(C.C.)(EETD 84) 66(OHMSTADS 81) 60 MIN(ASTM D 396) 174(O.C.)(TWARDUS 80) 80(FINGAS 79) >66(CURL 77) 99(YUEN 70)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
0	115(TWARDUS 80) 151(API 81)
5	222(API 81)
10	310(TWARDUS 80) 248(API 81)
15	259(API 81)
20	335(TWARDUS 80) 267(API 81)

10.0 ASTM DISTILLATION DATA CONT'D:

VOLUME PERCENT	TEMP (DEG C)
25	272(API 81)
30	345(TWARDUS 80) 277(API 81)
35	282(API 81)
40	350(TWARDUS 80) 286(API 81)
45	293(API 81)
50	355(TWARDUS 80) 299(API 81)
55	304(API 81)
60	367(TWARDUS 80) 312(API 81)
65	318(API 81)
70	370(TWARDUS 80) 326(API 81)
75	375(TWARDUS 80) 333(API 81)
80	344(API 81)
85	357(API 81)
90	387(API 81)
95	417(API 81)
FBP	441(API 81)

NOTE: (API 81) DATA FROM SIMULATED DISTILLATION METHOD ASTM D 2887

11.0 EMULSION FORMATION TENDENCY & STABILITY:

11.1 EMULSION FORMATION TENDENCY:

		WEATHERING (%)	
TEMP (DEG C)	0	..	..
0	0.1(EETD 84)		
15	0(EETD 84)		

NOTE: BUNKER C FROM THE ARROW INCIDENT FORMED STABLE EMULSIONS (YUEN 70)

11.2 EMULSION STABILITY:

		WEATHERING (%)	
TEMP (DEG C)	0	..	..
0	0.2(EETD 84)		
15	0.1(EETD 84)		

11.3 WATER CONTENT OF STABLE EMULSION (VOL %):

		WEATHERING (%)	
TEMP (DEG C)	0	..	..
0	N/A(EETD 84)		
15	N/A(EETD 84)		

12.0 WEATHERING:

13.0 SPREADING COEFFICIENT ON SEAWATER (mN/m or dynes/cm):

14.0 OTHERS:

14.1 IN-SITU COMBUSTION OF FRESH OIL: RELATIVELY LONG IGNITION TIME (1.9 MIN), 26.4 VOL % RESIDUE (TWARDUS 80)

14.2 AUTO IGNITION POINT (DEG C): 408 (OHMTADS 81)
407 (CURL 77)

14.3 BOILING POINT (DEG): 400 (OHMTADS 81)

14.4 TOTAL ASH CONTENT (WT %): 0.08 (YUEN 70)

14.5 POLAR CONTENT (WT %): 14.9 (MACKAY 82A)

14.6 NITROGEN CONTENT (WT %): 0.34(API 81)
0.94(PANCIROV 74)

14.7 FIRE POINT (DEG C): >257(TWARDUS 80), 164(YUEN 70)

14.8 INITIAL BOILING POINT (DEG C): 180 TO 500(FINGAS 79)

14.9 PARAFFINS (WT %): 24.4(MACKAY 82A)
15(CURL 77)

14.10 AROMATICS (WT %): 54.6(MACKAY 82A)
25(CURL 77)

14.11 WAX (WT %): 55.4(MACKAY 82A)

14.12 ASPHALTENES (WT %): 6.17(MACKAY 82A), 9.28(YUEN 70),
45(CURL 77)

14.13 CARBON RESIDUE (WT %): 12.00(YUEN 70)

14.14 SULPHUR (WT %): 2.40(API 81),1.46(PANCIROV 74),
2.24(YUEN 70)

14.15 METALS (PPM): NICKEL: 62(API 81),89(PANCIROV 74),
35(YUEN 70)
VANADIUM: 25 TO 26(API 81),
73(PANCIROV 74),
272(YUEN 70)

14.16 TOXICITY:
LC50:
ATLANTIC SALMON, FRESH WATER, 15 C: >10,000 PPM
ATLANTIC SALMON, FRESH WATER, 5 C: >10,000 PPM
WINTER FLOUNDERS, SEA WATER, 5 C: >10,000 PPM
AMERICAN LOBSTERS, SEA WATER, 5 C: >10,000 PPM
(YUEN 70)
COMBUSTION PRODUCTS: NO GREAT HAZARD(OHMTADS 81)
POTENTIAL FOR ACCUMULATION: NEGATIVE(OHMTADS 81)

COMPREHENSIVE DATA - FUEL OIL NO.2
PAGE 1

1.0 TYPE: FUEL OIL NO.2. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 30 MIN(ASTM 80), 31.6(PANCIROV 74)

4.0 DENSITY (g/ml):

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	0.874(EETD 84) 0.849(MACKAY 82B) 0.865 TO 0.908(CURL 77)		
15	0.866(EETD 84) 0.85(FINGAS 79) 0.855 TO 0.898(CURL 77)		
16.5	0.8762 MAX(ASTM D 396) 0.854 TO 0.897(CURL 77)		
20	0.840(MACKAY 82B)		

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	7.74(MACKAY 82B)		
20	4.04(MACKAY 82B)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (%) 0	..	..
15	15(FINGAS 79) 2.53 TO 6.13(CURL 77)		
38	2.0 TO 3.6(ASTM D 396) 1.53 TO 3.19(CURL 77)		
40	1.9 TO 3.4(ASTM D 396) 1.47 TO 3.01(CURL 77)		

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	29.0(EETD 84)		
15	27.4(EETD 84)		
20	26.2(MACKAY 82B)		

6.2 OIL-SEAWATER (mN/m or dynes/cm)

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	16.2(EETD 84)		
15	13.6(EETD 84)		
20	25.6(MACKAY 82B)		

7.0 POUR POINT (DEG C):

WEATHERING (%)	POUR POINT (DEG C)
0	-27(MACKAY 82B) -6 MAX(ASTM D 396) -20(FINGAS 79) -7(CURL 77)

8.0 FLASH POINT (DEG C):

WEATHERING (%)	FLASH POINT (DEG C)
0	104(MACKAY 82B) 38 MIN(ASTM D 396) 91(C.C.)(EETD 84) 52-96(EETD 84) 55(FINGAS 79) 38(CURL 77)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
INITIAL	180 TO 360 (FINGAS 79)
90	282 TO 338(ASTM D 396)

11.0 EMULSION FORMATION TENDENCY & STABILITY:

11.1 EMULSION FORMATION TENDENCY:

TEMP		WEATHERING (%)	
(DEG C)	0	..	..
0	0(EETD 84)		
15	0(EETD 84)		

11.2 EMULSION STABILITY: FORMS NO EMULSION (MACKAY 82B)

TEMP		WEATHERING (%)	
(DEG C)	0	..	..
0	0(EETD 84)		
15	0(EETD 84)		

11.3 WATER CONTENT OF STABLE EMULSION (VOL %):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	N/A(EETD 84)		
15	N/A(EETD 84)		

12.0 WEATHERING:

13.0 SPREADING COEFFICIENT ON SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	26.0(EETD 84)		
15	28.2(EETD 84)		

14.0 OTHERS:

14.1 AUTO-IGNITION POINT (DEG C): 257 (OHMTADS 81)

14.2 BOILING POINT (DEG C): 232 (OHMTADS 81)

14.3 BOILING RANGE (DEG C): 34 TO 185(CURL 77)

14.4 ODOUR THRESHOLD,MEDIUM (PPM): 0.082 (OHMTADS 81)

14.5 COLOUR IN WATER: DARK BLUE PURPLE (OHMTADS 81)

14.6 NITROGEN CONTENT (WT %): 0.024 (PANCIROV 74)

14.7 SULPHUR (WT %): 0.5 MAX(ASTM D 396),0.32(PANCIROV 74)

14.8 METALS (PPM): NICKEL: 0.5(PANCIROV74)
VANADIUM: 1.5(PANCIROV 74)

14.9 TOXICITY:
COMBUSTION PRODUCT TOXICITY: NO GREAT HAZARD (OHMTADS 81)
POTENTIAL FOR ACCUMULATION: NEGATIVE (OHMTADS 81)
GENERAL EFFECT: INHALATION: HEADACHE, & STUPOR (OHMTADS 81)

14.10 AQUEOUS SOLUBILITY (mg/L): 3.12 @ 20 DEG C (MACKAY 82B)

COMPREHENSIVE DATA - HIBERNIA CRUDE OIL
PAGE 1

1.0 TYPE: HIBERNIA CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API. GRAVITY:

4.0 DENSITY (g/ml):

$$\mathrm{DEN} = 0.845 + 0.00234\ \mathrm{Fw} - 0.00058\ T$$

where: DEN is density of oil at T and Fw (g/ml)
Fw is weight fraction of oil weathered
T is oil temperature (deg C)

TEMP (DEG C)	WEATHERING (WT %) 0	9.0	20.3
0	0.851(EETD 84) 0.843(MACKAY 82A)	0.867(EETD 84)	0.897(EETD 84)
5	0.841(MACKAY 82A)		
10	0.840(MACKAY 82A)		
15	0.844(EETD 84) 0.839(MACKAY 82A)	0.856(EETD 84)	0.886(EETD 84)
20	0.837(MACKAY 82A)		
25	0.836(MACKAY 82A)		

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (WT %)		
	0	9.0	20.3
0	575(EETD 84)	>1000(EETD 84)	>5200(EETD 84)
5	148(MACKAY 82A)		
10	72.4(MACKAY 82A)		
15	11.4(EETD 84)	83(EETD 84)	438(EETD 84)
20	33.2(MACKAY 82A)		
25	25.6(MACKAY 82A)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (WT %)		
	0	9.0	20.3
0	675.7(EETD 84)	>1150(EETD 84)	>5780(EETD 84)
5	176(MACKAY 82A)		
10	86.2(MACKAY 82A)		
15	13.5(EETD 84)	97(EETD 84)	94.4(EETD 84)
20	39.7(MACKAY 82A)		
25	30.6(MACKAY 82A)		

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (VOL %)		
	0	9.0	20.3
0	28.0(EETD 84)	28.4(EETD 84)	N/M(EETD 84)
15	26.4(EETD 84)	25.8(EETD 84)	27.9(EETD 84)

6.2 OIL-SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (VOL %) 0	9.0	20.3
0	25.2(EETD 84)	33.2(EETD 84)	N/M(EETD 84)
15	20.5(EETD 84)	25.6(EETD 84)	26.7(EETD 84)

7.0 POUR POINT (DEG C):

WEATHERING (WT %)	POUR POINT (DEG C)
0	6(MACKAY 82A)
9	21(EETD 84)
20.3	24(EETD 84)

8.0 FLASH POINT (DEG C):

WEATHERING (WT %)	FLASH POINT (DEG C)
0	14(EETD 84)
9	33(EETD 84)
20.3	66(EETD 84)

9.0 VAPOUR PRESSURE (kPa): 63.5(EETD 84)

10.0 ASTM DISTILLATION DATA:

11.0 EMULSION FORMATION TENDENCY & STABILITY:

11.1 EMULSION FORMATION TENDENCY:

TEMP (DEG C)	WEATHERING (WT %) 0	9.0	20.3
0	1.0(EETD 84)	1.0(EETD 84)	0.24(EETD 84)
15	0.16(EETD 84)	0.22(EETD 84)	1.0(EETD 84)

11.2 EMULSION STABILITY:

TEMP (DEG C)	WEATHERING (WT %) 0	9.0	20.3
0	1.0(EETD 84)	1.0(EETD 84)	1.0(EETD 84)
15	0.37(EETD 84)	0.71(EETD 84)	1.0(EETD 84)

11.3 WATER CONTENT OF STABLE EMULSION (VOL %):

TEMP (DEG C)	WEATHERING (WT %) 0	9.0	20.3
0	88(EETD 84)	87(EETD 84)	69(EETD 84)
15	89(EETD 84)	89(EETD 84)	88(EETD 84)

12.0 WEATHERING:

$$Fv = \frac{\ln(1 + 5974\ \theta\ \exp(6.3 - 4141/TK)/TK)}{(5974/TK)}$$

where: Fv is fraction of oil weathered by volume
ln is natural log
θ is evaporation exposure
exp is exponential base e
TK is environmental temperature
(Kelvin, K = deg C + 273)
(EETD 84)

13.0 SPREADING COEFFICIENT ON SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (VOL %) 0	9.0	20.3
0	18.0(EETD 84)	9.6(EETD 84)	<0(EETD 84)
15	22.7(EETD 84)	17.8(EETD 84)	14.6(EETD 84)

14.0 OTHERS:

14.1 SOLUBILITY (mg/L):

	WEATHERING (WT %)		
DISSOLVED IN	0	9.0	20.3
WATER	29.06(ROSS 84)		
SEAWATER	16.92(ROSS 84)	12.1(ROSS 84)	2.36(ROSS 84)

14.2 PARAFFINS (WT %): 79.3(MACKAY 82A)

14.3 AROMATICS (WT %): 14.5(MACKAY 82A)

14.4 WAX (WT %): 8.47(MACKAY 82A)

14.5 ASPHALTENES (WT %): 2.68(MACKAY 82A)

14.6 CHEMICAL DISPERSIBILITY:

	OIL TO DISPERSANT RATIO AT 50% DISPERSION		
TEMP	WEATHERING (WT %)		
(DEG C)	0	9.0	20.3
0	<10(EETD 84)	<10(EETD 84)	<10(EETD 84)
15	37(EETD 84)	14(EETD 84)	<10(EETD 84)

COMPREHENSIVE DATA - ISTHMUS BLEND CRUDE OIL, MEXICO

1.0 TYPE: ISTHMUS/REFORMA/CACTUS REFORMA BLEND CRUDE OIL, MEXICO. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 33.0(McCASLIN 79)

4.0 DENSITY (g/ml):

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
15.9	22.9(McCASLIN 79)		
37.8	7.1(PEREZ 79)		
39	6.81(McCASLIN 79)		

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -16(PEREZ 79)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa): 22.8(McCASLIN 79),
38.6(PEREZ 79)

10.0 ASTM DISTILLATION DATA:

11.0 EMULSION FORMATION TENDENCY & STABILITY:

12.0 WEATHERING:

13.0 SPREADING COEFFICIENT ON SEAWATER (mN/m or dynes/cm):

14.0 OTHERS:

14.1 NAPHTHENES (VOL %): ABOUT 3.6(McCASLIN 79)

14.2 PARAFFINS (WT %): ABOUT 12 VOL %(McCASLIN 79)

14.3 AROMATICS (WT %): ABOUT 1.4 VOL %(McCASLIN 79)

14.4 CARBON RESIDUE (WT %): 3.5(RAMSBOTTOM)(PEREZ 79)

14.5 SULPHUR (WT %): 1.56(McCASLIN 79), 1.7(PEREZ 79)

14.6 METALS (PPM): VANADIUM: 21.1(PEREZ 79),
NICKEL: 3.0(PEREZ 79)

COMPREHENSIVE DATA - LAGO MEDIO CRUDE OIL, VENEZUELA

1.0 TYPE: LAGO MEDIO CRUDE OIL, VENEZUELA. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 32.6(McCASLIN 79)

4.0 DENSITY (g/ml):

$$DEN = 0.880 + 0.00167\ Fv - 0.00056\ T$$

Where: DEN is density at Fv & T (g/ml)
Fv is volume fraction weathered
T is oil temperature (deg C)

TEMP (DEG C)	WEATHERING (VOL %) 0	8.86	14.8
0	0.880(EETD 84)	0.898(EETD 84)	0.906(EETD 84)
15	0.872(EETD 84)	0.891(EETD 84)	0.897(EETD 84)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (VOL %) 0	8.86	14.8
0	4355(EETD 84)	7800(EETD 84)	16500(EETD 84)
15	41.1(EETD 84)	83.6(EETD 84)	265(EETD 84)

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (VOL %) 0	8.86	14.8
0	4949(EETD 84)	8686(EETD 84)	18212(EETD 84)
15	47.1(EETD 84)	93.8(EETD 84)	295(EETD 84)

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (VOL %) 0	8.86	14.8
0	N/M(EETD 84)	N/M(EETD 84)	N/M(EETD 84)
15	28.2(EETD 84)	27.5(EETD 84)	29.6(EETD 84)

6.2 OIL-SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (VOL %) 0	8.86	14.8
0	N/M(EETD 84)	N/M(EETD 84)	N/M(EETD 84)
15	12.4(EETD 84)	14.4(EETD 84)	17.1(EETD 84)

6.3 OIL-WATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (VOL %) 0	8.86	14.8
0	N/M(EETD 84)	N/M(EETD 84)	N/M(EETD 84)
15	23.2(EETD 84)	23.7(EETD 84)	20.5(EETD 84)

7.0 POUR POINT (DEG C): -26(McCASLIN 79)

8.0 FLASH POINT (DEG C): 57(C.C.)(EETD 84)

9.0 VAPOUR PRESSURE (kPa): 15.5(EETD 84)

10.0 ASTM DISTILLATION DATA:

11.0 EMULSION FORMATION TENDENCY & STABILITY:

11.1 EMULSION FORMATION TENDENCY:

TEMP (DEG C)	WEATHERING (VOL %) 0	8.9	14.8
0	0.9(EETD 84)	1.0(EETD 84)	1.0(EETD 84)

11.2 EMULSION STABILITY:

TEMP (DEG C)	WEATHERING (VOL %) 0	8.9	14.8
0	0.92(EETD 84)	0.9(EETD 84)	1.0(EETD 84)

11.3 WATER CONTENT OF STABLE EMULSION (VOL %):

TEMP (DEG C)	WEATHERING (VOL %) 0	8.9	14.8
0	89.1(EETD 84)	84.9(EETD 84)	73.4(EETD 84)

12.0 WEATHERING:

$$Fv = \frac{\ln(1 + 6334.5\ 8\ \exp(6.3 - 4717.4/TK)/TK)}{(6334.5/TK)}$$

where: Fv is fraction of oil weathered by volume
ln is natural log
8 is evaporation exposure
exp is exponential base e
TK is environmental temperature
(Kelvin, K = deg C + 273)

(Stiver 82)

13.0 SPREADING COEFFICIENT ON SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (VOL %) 0	8.86	14.8
0	<0(EETD 84)	<0(EETD 84)	<0(EETD 84)
15	28.6(EETD 84)	27.3(EETD 84)	22.5(EETD 84)

14.0 OTHERS:

14.1 CARBON RESIDUE (WT %): 4.36(McCASLIN 79)

14.2 SULPHUR (WT %): 1.23(McCASLIN 79)

14.3 AQUEOUS SOLUBILITY (mg/L):

WEATHERING (WT %)	SOLUBILITY (mg/L)
0	25.5(BOBRA 83)
22.3	0.61(BOBRA 83)

COMPREHENSIVE DATA - NORMAN WELLS CRUDE OIL
PAGE 1

1.0 TYPE: NORMAN WELLS CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml):

$$DEN = 0.843 + 0.00183\ Fw - 0.00069\ T$$

where: DEN is density of oil at T and Fw (g/ml)
Fw is weight fraction of oil weathered
T is oil temperature (deg C)

TEMP (DEG C)	WEATHERING (WT %)		
	0	12	20.4
0	0.845 (MACKAY 82A) 0.840 (MACKAY 75)	0.864 (MACKAY 75)	0.881 (MACKAY 75)
5	0.841 (MACKAY 82A)		
10	0.839 (MACKAY 82A)		
15	0.832 (EETD 84) 0.834 (MACKAY 82A) 0.832 (MACKAY 75)	0.855 (MACKAY 75)	0.873 (MACKAY 75)
20	0.832 (MACKAY 82A)		
25	0.829 (MACKAY 82A)	0.844 (MACKAY 75)	0.863 (MACKAY 75)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

VISC = exp(2.26 - 2461.7 T/(273(T+273)))
where: VISC is dynamic viscosity of oil at T (mPa.s)
exp is exponential base e
T is oil temperature (deg C)

TEMP (DEG C)	WEATHERING (WT %)		
	0	20.4	42.3
-25	22(MACKAY 75)	99(MACKAY 75)	
-15	18(MACKAY 75)	69(MACKAY 75)	
0	8.76(MACKAY 82A) 14.2(TWARDUS 80) 11(MACKAY 75)	40(MACKAY 75)	300(MACKAY 75)
5	7.11(MACKAY 82A)		
10	5.81(MACKAY 82A) 8.68(TWARDUS 80) 9(MACKAY 75)	28(MACKAY 75)	180(MACKAY 75)
15	5.05(MACKAY 82A) 7.9(MACKAY 75)	25(MACKAY 75)	150(MACKAY 75)
20	4.39(MACKAY 82A) 5.9(TWARDUS 80)		
25	3.93(MACKAY 82A) 6.1(MACKAY 75)	15(MACKAY 75)	80(MACKAY 75)

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (WT %) 0	20.4	42.3
0	10.37(MACKAY 82A) 13.1(MACKAY 75)	46(MACKAY 75)	34(MACKAY 75)
5	8.45(MACKAY 82A)		
10	6.93(MACKAY 82A)		
15	6.06(MACKAY 82A) 9.5(MACKAY 75)	29(MACKAY 75)	172(MACKAY 75)
20	5.28(MACKAY 82A)		
25	4.74(MACKAY 82A)	18(MACKAY 75)	93(MACKAY 75)

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (%) 0	20.4	36.7
0	24.9(EETD 84)		
5	23.7(MACKAY 75)	28.2(MACKAY 75)	29.8(MACKAY 75)
15	23.6(EETD 84)		
25	22.7(MACKAY 75)	27(MACKAY 75)	28.5(MACKAY 75)

6.2 OIL-SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	16.5(EETD 84)		
15	16.4(EETD 84)		

6.3 INTERFACIAL TENSION OF OIL-WATER (mN/m or dynes/cm):
2.68 AT ROOM TEMP.(TWARDUS 80)

7.0 POUR POINT (DEG C):

WEATHERING (WT %)	POUR POINT (DEG C)
0	<-50(MACKAY 82A) -85(TWARDUS 80) -50(MACKAY 75)
10	<-50(MACKAY 82A)
12	-34(MACKAY 75)
20	<-50(MACKAY 82A)
20.4	-26(MACKAY 75)
36.7	-12(MACKAY 75)

NOTES: Pour Point = -51 + 1.50 E - 0.012 E**2
WHERE: E = WT % EVAPORATED (MACKAY 75)

8.0 FLASH POINT (DEG C): 3(C.C.)(EETD 84)

9.0 VAPOUR PRESSURE (kPa): 36.2(EETD 84)

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
0	60(MACKAY 75)
10	118(MACKAY 75)
20	145(MACKAY 75)
30	174(MACKAY 75)
40	223(MACKAY 75)
50	280(MACKAY 75)

DATA OBTAINED FROM A CURVE(MACKAY 75)

11.0 EMULSION FORMATION TENDENCY & STABILITY:

11.1 EMULSION FORMATION TENDENCY:

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	0(EETD 84)		
15	0(EETD 84)		

11.2 EMULSION STABILITY:

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	0(EETD 84)		
15	0(EETD 84)		

11.3 WATER CONTENT OF STABLE EMULSION (VOL %):

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	N/A(EETD 84)		
15	N/A(EETD 84)		

12.0 WEATHERING:

$$Fv = \frac{\ln(1 + 5315.8\ \theta\ \exp(6.3 - 3911.9/TK)/TK)}{(5315.8/TK)}$$

where: Fv is fraction of oil weathered by volume
ln is natural log
θ is evaporation exposure
exp is exponential base e
TK is environmental temperature
(Kelvin, K = deg C + 273)

(EETD 84)

13.0 SPREADING COEFFICIENT ON SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	29.8(EETD 84)		
15	29.2(EETD 84)		

14.0 OTHERS:

14.1 FIRE POINT (DEG C): <13.5 (TWARDUS 80)

14.2 AQUEOUS SOLUBILITY (mg/L):

WEATHERING (WT %)	SOLUBILITY (mg/L)
0	32.3(MACKAY 75) 32.3(BOBRA 83)
6	23.18(MACKAY 75) 27.0(BOBRA 83)
12	14.59(MACKAY 75) 14.6(BOBRA 83)
20.4	7.33(MACKAY 75) 7.3(BOBRA 83)
29	2.27(MACKAY 75)
36	0.68(BOBRA 83)
43.2	0.14(BOBRA 83)

14.3 PARAFFINS (WT %):

WEATHERING (WT %)	PARAFFINS (WT %)
0	85.1(MACKAY 82A)
10	82.2(MACKAY 82A)
20	80.0(MACKAY 82A)

14.4 AROMATICS (WT %):

WEATHERING (WT %)	AROMATICS (WT %)
0	11.4(MACKAY 82A)
10	11.5(MACKAY 82A)
20	13.1(MACKAY 82A)

14.5 WAX (WT %):

WEATHERING (WT %)	WAX (WT %)
0	1.76(MACKAY 82A)
10	2.29(MACKAY 82A)
20	1.90(MACKAY 82A)

14.6 ASPHALTENES (WT %):

WEATHERING (WT %)	ASPHALTENES (WT %)
0	1.13(MACKAY 82A)
10	2.88(MACKAY 82A)
20	3.20(MACKAY 82A)

COMPREHENSIVE DATA - PRUDHOE BAY CRUDE OIL

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1.0 TYPE: PRUDHOE BAY CRUDE OIL. TYPICAL DATA

2.0 COLOUR: BROWNISH BLACK(USCG 72)

3.0 API GRAVITY: 27.0(USCG 72)

4.0 DENSITY (g/ml):

$$DEN = 0.915 + 0.00153\ Fw - 0.00103\ T$$

where: DEN is density of oil at T and Fw (g/ml)
Fw is weight fraction of oil weathered
T is oil temperature (deg C)

TEMP (DEG C)	WEATHERING (WT %)				
	0	7.3	9.8	11.2	24.1
0	0.915 (MACKAY 82A) 0.909 (MACKAY 82B)				
5	0.911 (MACKAY 82A) 0.906 (MACKAY 75)		0.925 (MACKAY 75)		0.950 (MACKAY 75)
10	0.910 (MACKAY 82A)				
15	0.905 (MACKAY 82A) 0.899 (MACKAY 75)		0.916 (MACKAY 75)		0.937 (MACKAY 75)
20	0.902 (MACKAY 82A) 0.884 (MACKAY 80A) 0.881 (USCG 71) 0.901 (MACKAY 82B)	0.902 (MACKAY 82A)		0.910 (MACKAY 80A)	
25	0.900 (MACKAY 82A) 0.888 (MACKAY 75)		0.905 (MACKAY 75)		0.928 (MACKAY 75)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)			WEATHERING (WT %)		
	0	7.3	9.8	11.2	24.1
-20	180 (MACKAY 75)		540 (MACKAY 75)		3700 (MACKAY 75)
-15	135 (MACKAY 75)		420 (MACKAY 75)		4000 (MACKAY 75)
- 8	1000 (MARTIN 77)				
- 2	170 (MARTIN 77)				
0	577 (MACKAY 82A) 500 (MACKAY 82B) 50 (MACKAY 80A) 19 (MARTIN 77) 68 (MACKAY 75)	108 (MACKAY 80A)	205 (MACKAY 75)	204 (MACKAY 80A)	1700 (MACKAY 75)
5	196 (MACKAY 82A) 140 (USCG 71)				
10	103 (MACKAY 82A) 80 (USCG 71) 96 (MACKAY 82B)				
15	68.4 (MACKAY 82A) 26 (MACKAY 80A) 33 (MACKAY 75) 50 (USCG 71)	62 (MACKAY 80A)	102 (MACKAY 75)	105 (MACKAY 80A)	820 (MACKAY 75)

5.1 DYNAMIC VISCOSITY (mPa.s or cp) (Cont'd):

TEMP (DEG C)	WEATHERING (WT %) 0	7.3	9.8	11.2	24.1
20	45.7 (MACKAY 82A) 34.9 (MACKAY 82B)				
25	35.3 (MACKAY 82A) 17 (MACKAY 80) 20 (MACKAY 75)	37 (MACKAY 80A)	55 (MACKAY 75)	61 (MACKAY 80A)	400 (MACKAY 75)

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (WT %) 0	9.8	24.1
0	630 (MACKAY 82A)		
5	216 (MACKAY 82A)		
10	113 (MACKAY 82A)		
15	75.5 (MACKAY 82A) 37 (MACKAY 75)	111 (MACKAY 75)	878 (MACKAY 75)
20	50.7 (MACKAY 82A)		
25	39.2 (MACKAY 82A) 23 (MACKAY 75)	61 (MACKAY 75)	431 (MACKAY 75)

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm):

-SURFACE TENSION = 30.0 (1 + F)
WHERE: F = VOL FRACTION EVAPORATED (MACKAY 82B),

-@ 20 DEG C: 30.1(MACKAY 82B)

6.2 OIL-SEAWATER (mN/m or dynes/cm):

-INTERFACIAL TENSION = 27.0 (1 + 2.0 F)
WHERE: F = VOL FRACTION EVAPORATED (MACKAY 82B),

-@ ? TEMP: 14.8 (MACKAY 82A),

-@ 20 DEG C: 27.0(MACKAY 82B)

7.0 POUR POINT (DEG C):

WEATHERING (WT %)	POUR POINT (DEG C)
0	0(MACKAY 82A) -27(MACKAY 80) -9.5(MARTIN 77) -42(MACKAY 75) -9.1(USCG 72) -2(MACKAY 82B)
7.3	-16(MACKAY 80)
9.8	-27(MACKAY 75)
11.2	-3(MACKAY 80)
18.2	-18(MACKAY 75)
24.1	-11(MACKAY 75)

8.0 FLASH POINT (DEG C):

WEATHERING (WT %)	FLASH POINT (DEG C)
0	30(O.C.)(MACKAY 80)
7.3	71(O.C.)(MACKAY 80)
11.2	84(O.C.)(MACKAY 80)

NOTES: FLASH POINT = 70.0 (1 + 3.7 F)
WHERE: F = VOL FRACTION EVAPORATED (MACKAY 82B)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
0	50(MACKAY 75)
10	168(MACKAY 75)
20	235(MACKAY 75)
30	290(MACKAY 75)
40	328(MACKAY 75)

DATA OBTAINED FROM A CURVE(MACKAY 75)

INITIAL BOILING POINT: 67(MACKAY 80)

11.0 EMULSION FORMATION TENDENCY & STABILITY: FORMS FAIRLY STABLE EMULSION(MACKAY 82B)

12.0 WEATHERING:

13.0 SPREADING COEFFICIENT ON SEAWATER (mN/m or dynes/cm):

14.0 OTHERS:

14.1 FIRE POINT (DEG C):

WEATHERING (WT %)	FIRE POINT (DEG C)
0	35(MACKAY 80)
7.3	86(MACKAY 80)
11.2	91(MACKAY 80)

14.2 AQUEOUS SOLUBILITY (mg/L):

WEATHERING (WT %)	AQUEOUS SOLUBILITY (mg/L)
0	41.7(MACKAY 80) 29.25(MACKAY 75) 29.3(BOBRA 83) 29.2 @ 20 DEG C(MACKAY 82B)
7.3	15.0(MACKAY 80)
9.8	4.89(MACKAY 75) 4.91(BOBRA 83)
11.2	7.6(MACKAY 80)
18.2	0.153(BOBRA 83)
24.4	0.102(BOBRA 83)

NOTES: SOLUBILITY = 29.2 EXP(-12.0 Fv)
WHERE: Fv = VOL FRACTION EVAPORATED (MACKAY 82B)

14.3 INITIAL BOILING POINT (DEG C):

WEATHERING (WT %)	IBP (DEG C)
0	67(MACKAY 80)
7.3	102(MACKAY 80)
11.2	192(MACKAY 80)

14.4 PARAFFINS (WT %): 86.9(MACKAY 82A)

14.5 AROMATICS (WT %): 9.94(MACKAY 82A)

14.6 WAX (WT %): 3.86(MACKAY 82A)
WAX (MASS FRACTION) = 0.045 / (1 - F)
WHERE: F = VOL FRACTION EVAPORATED(MACKAY 82B)

14.7 ASPHALTENES (WT %): 1.53(MACKAY 82A)
ASPHALTENE (MASS FRACTION) = 0.024 / (1 - F)
WHERE: F = VOL FRACTION EVAPORATED(MACKAY 82B)

14.8 CARBON RESIDUE (WT %): 4.7 %(USCG 72)

14.9 SULPHUR (WT %): 0.82(USCG 72)

COMPREHENSIVE DATA - SABLE ISLAND CONDENSATE

1.0 TYPE: SABLE ISLAND LIQUID CONDENSATE. TYPICAL DATA.

2.0 COLOUR: CLEAR, PALE YELLOW(HUTCHESON 83)

3.0 API GRAVITY: 39.9(ROSS 82A)

4.0 DENSITY (g/ml):

TEMP (DEG C)	WEATHERING (%) 0	41	71	82
0	0.878 (MACKAY 82A)			
5	0.834 (ROSS 82A) 0.876 (MACKAY 82A)	0.875 (ROSS 82A)	0.885 (ROSS 82A)	0.914 (ROSS 82A)
10	0.875 (MACKAY 82A)			
15	0.823 (ROSS 82A) 0.874 (MACKAY 82A)	0.869 (ROSS 82A)	0.870 (ROSS 82A)	0.899 (ROSS 82A)
20	0.872 (MACKAY 82A)			
25	0.869 (MACKAY 82A)			

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%) 0	41	71	82
0	12.8 (MACKAY 82A)			
5	2.7 (ROSS 82A) 4.96 (MACKAY 82A)	88.0 (ROSS 82A)	2250 (ROSS 82A)	6600 (ROSS 82A)
10	3.39 (MACKAY 82A)			
15	2.02 (ROSS 82A) 2.96 (MACKAY 82A)	5.55 (ROSS 82A)	320 (ROSS 82A)	2450 (ROSS 82A)
20	2.67 (MACKAY 82A)			
25	2.41 (MACKAY 82A)			

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP	WEATHERING (%)			
(DEG C)	0	41	71	82
0	14.6 (MACKAY 82A)			
5	3.2 (ROSS 82A) 5.66 (MACKAY 82A)	100.6 (ROSS 82A)	2542 (ROSS 82A)	7221 (ROSS 82A)
10	3.87 (MACKAY 82A)			
15	2.45 (ROSS 82A) 3.39 (MACKAY 82A)	6.39 (ROSS 82A)	368 (ROSS 82A)	2725 (ROSS 82A)
20	3.06 (MACKAY 82A)			
25	2.77 (MACKAY 82A)			

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm): 28.5 @ ? TEMP (ROSS 82A)

6.2 OIL-SEAWATER (mN/m or dynes/cm):
29.6 @ ? TEMP (ROSS 82A),
18.4 @ ? TEMP (MACKAY 82A)

7.0 POUR POINT (DEG C):

WEATHERING (%)	POUR POINT (DEG C)
0	-22(ROSS 82A) 3(MACKAY 82A)
41	3(ROSS 82A)
71	18(ROSS 82A)
82	27(ROSS 82A)

8.0 FLASH POINT (DEG C):

WEATHERING (%)	FLASH POINT (DEG C)
0	16(O.C.)(ROSS 82A)
41	81(O.C.)(ROSS 82A)
71	135(O.C.)(ROSS 82A)
82	147(O.C.)(ROSS 82A)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

VOL FRACTION	TEMP (DEG C)
0.15	103(ROSS 82A)
0.30	123(ROSS 82A)
0.50	156(ROSS 82A)
0.70	220(ROSS 82A)

11.0 EMULSION FORMATION TENDENCY & STABILITY:

12.0 WEATHERING:

13.0 SPREADING COEFFICIENT ON SEAWATER (mN/m or dynes/cm):

14.0 OTHERS:

14.1 FIRE POINT (DEG C):

WEATHERING (%)	FIRE POINT (DEG C)
0	16(ROSS 82A)
41	84(ROSS 82A)
71	141(ROSS 82A)
82	161(ROSS 82A)

14.2 SOLUBILITY (mg/L):

DISSOLVED IN	WEATHERING (%) 0	WEATHERING (%) 42
DOUBLE DISTILLED WATER	58.08(ROSS 82A)	5.34(ROSS 82A)
SEAWATER	74.65(ROSS 82A)	8.02(ROSS 82A)

14.3 PARAFFINS (WT %): 81.07(ROSS 82A), 88.4(MACKAY 82A)

14.4 AROMATICS (WT %): 10.8(MACKAY 82A)

14.5 WAX (WT %): 2.01(MACKAY 82A)

14.6 ASPHALTENES (WT %): 0.60(MACKAY 82A)

14.7 H_2S (PPM): 0(ROSS 82A)

14.8 CHEMICAL DISPERSIBILITY: LITTLE TENDENCY TO DISPERSE AT 5C FOR FRESH AND 42% WEATHERED OIL(ROSS 82A)

14.9 TOXICITY:

NOTE: TOXICITY TESTS USED VENTURE FIELD CONDENSATE FROM INTERVALS 4678 TO 4691 m.

A) RAINBOW TROUT (15 C, WATER):
LC50: 5.6 µL/L @ 96 H & 6.0 µL/L @ 24 H
LTC: 5 µL/L
INCIPIENT LETHAL THRESHOLD CONC: 5 µL/L
ET50 (SWIMMING): < 1 H
EC50 (SWIMMING): <4.9 µL/L
(HUTCHESON 83)

B) GREEN SEA URCHIN (10 C, SEAWATER):
LTC: ABOUT 40.5 µL/L
INCAPACITATED ABOUT 3.8 µL/L
NO ACUTE OR DELAY MORTALITIES UP TO 33.5 µL/L AFTER 96H
DELAY MORTALITIES > OR = 33.5 µL/L
(HUTCHESON 83)

1.0 TYPE: SOUR BLEND CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml):

DEN = 0.853 - 0.00063 T
where: DEN is density of fresh oil at T (g/ml)
T is oil temperature (deg C)

TEMP (DEG C)	WEATHERING (WT %) 0	10	20
0	0.861(EETD 84) 0.852(MACKAY 82A)		
5	0.850(MACKAY 82A)		
10	0.847(MACKAY 82A)		
15	0.850(EETD 84) 0.842(MACKAY 82A)		
20	0.840 (MACKAY 82A)	0.861 (MACKAY 82A)	0.875 (MACKAY 82A)
25	0.836(MACKAY 82A)		

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

VISC = exp(3.189 - 4691.9 T/(273(T+273)))
where: VISC is dynamic viscosity of fresh oil at T (mPa.s)
exp is exponential base e
T is oil temperature (deg C)

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	24.2(MACKAY 82A) 26.7(TWARDUS 80)		
5	16.9(MACKAY 82A)		
10	10.9(MACKAY 82A) 19.4(TWARDUS 80)		
15	8.20(MACKAY 82A)		
20	6.59(MACKAY 82A) 9.5(TWARDUS 80)		
25	5.95(MACKAY 82A)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	28.4(MACKAY 82A)		
5	19.9(MACKAY 82A)		
10	12.9(MACKAY 82A)		
15	9.74(MACKAY 82A)		
20	7.85(MACKAY 82A)		
25	7.12(MACKAY 82A)		

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
15	25.8(EETD 84)		

NOTES: @ ROOM TEMP: 24.1(TWARDUS 80)

6.2 OIL-SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (%) 0	..	..
15	0.75(EETD 84)		

6.3 OIL-WATER (mN/m or dynes/cm): 27.5 @ ROOM TEMP (TWARDUS 80)

7.0 POUR POINT (DEG C):

WEATHERING (WT %)	POUR POINT (DEG C)
0	6(MACKAY 82A) -50(TWARDUS 80)
10	6(MACKAY 82A)
20	9(MACKAY 82A)

8.0 FLASH POINT (DEG C): 6.6(C.C.)(EETD 84)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
0	45(TWARDUS 80)
10	95(TWARDUS 80)
20	130(TWARDUS 80)
30	180(TWARDUS 80)
40	235(TWARDUS 80)
50	300(TWARDUS 80)
60	345(TWARDUS 80)
70	380(TWARDUS 80)
80	385(TWARDUS 80)
85	390(TWARDUS 80)

11.0 EMULSION FORMATION TENDENCY & STABILITY:

11.1 EMULSION FORMATION TENDENCY:

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	0.58(EETD 84)		
15	0(EETD 84)		

11.2 EMULSION STABILITY:

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	0.9(EETD 84)		
15	0.1(EETD 84)		

11.3 WATER CONTENT OF STABLE EMULSION (VOL %):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	92.3(EETD 84)		
15	N/A(EETD 84)		

12.0 WEATHERING:

$$Fv = \frac{\ln(1 + 5217\ 8\ \exp(6.3 - 3975.8/TK)/TK)}{(5217/TK)}$$

where: Fv is fraction of oil weathered by volume
ln is natural log
8 is evaporation exposure
exp is exponential base e
TK is environmental temperature
(Kelvin, K = deg C + 273)

(EETD 84)

13.0 SPREADING COEFFICIENT ON SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
15	42.6(EETD 84)		

14.0 OTHERS:

14.1 FIRE POINT (DEG C): <10.5(TWARDUS 80)

14.2 PARAFFINS (WT %):

WEATHERING (WT %)	PARAFFINS (WT %)
0	82.3(MACKAY 82A)
10	76.9(MACKAY 82A)
20	72.5(MACKAY 82A)

14.3 AROMATICS (WT %):

WEATHERING (WT %)	AROMATICS (WT %)
0	13.2(MACKAY 82A)
10	14.7(MACKAY 82A)
20	16.4(MACKAY 82A)

14.4 WAX (WT %):

WEATHERING (WT %)	WAX (WT %)
0	5.62(MACKAY 82A)
10	8.49(MACKAY 82A)
20	9.95(MACKAY 82A)

14.5 ASPHALTENES (WT %):

WEATHERING (WT %)	ASPHALTENES (WT %)
0	2.21(MACKAY 82A)
10	4.58(MACKAY 82A)
20	6.73(MACKAY 82A)

14.6 IN-SITU COMBUSTION OF FRESH OIL: EASILY IGNITED, 5.0 WT % RESIDUE(TWARDUS 80)

COMPREHENSIVE DATA - SWEET BLEND CRUDE OIL

1.0 TYPE: SWEET BLEND CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml):

$$DEN = 0.8406 - 0.0006\ T$$

where: DEN is density of fresh oil at T (g/ml)
T is oil temperature (deg C)

TEMP (DEG C)	WEATHERING (WT %) 0	10	20
0	0.840 (MACKAY 82A)		
5	0.838 (MACKAY 82A)		
10	0.835 (MACKAY 82A)		
15	0.831 (MACKAY 82A)		
20	0.829 (MACKAY 82A)	0.847 (MACKAY 82A)	0.859 (MACKAY 82A)
25	0.825 (MACKAY 82A)		

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

$$VISC = \exp(2.89 - 4886.5\ T/(273(T+273)))$$

where: VISC is dynamic viscosity of fresh oil at T (mPa.s)
exp is exponential base e
T is oil temperature (deg C)

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	21.0(MACKAY 82A) 20.1(TWARDUS 80)		
5	11.5(MACKAY 82A)		
10	7.99(MACKAY 82A) 14.2(TWARDUS 80)		
15	5.31(MACKAY 82A)		
20	4.77(MACKAY 82A) 8.1(TWARDUS 80)		
25	4.13(MACKAY 82A)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	25(MACKAY 82A)		
5	13.7(MACKAY 82A)		
10	9.6(MACKAY 82A)		
15	6.39(MACKAY 82A)		
20	5.75(MACKAY 82A)		
25	5.01(MACKAY 82A)		

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm): @ ROOM TEMP: 24 (TWARDUS 80)

6.2 OIL-SEAWATER (mN/m or dynes/cm): @ ? TEMP: 19.5; 16.9 @ 10 WT % WEATHERING; 20.2 @ 20 WT % WEATHERING(MACKAY 82A)

6.3 OIL-WATER (mN/m or dynes/cm): 27.3 @ ROOM TEMP (TWARDUS 80)

7.0 POUR POINT (DEG C):

WEATHERING (WT %)	POUR POINT (DEG C)
0	-33(MACKAY 82A) -35(TWARDUS 80)
10	-27(MACKAY 82A)
20	6(MACKAY 82A)

8.0 FLASH POINT (DEG C): <9(O.C.)(TWARDUS 80)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
0	50(TWARDUS 80)
10	95(TWARDUS 80)
20	130(TWARDUS 80)
30	185(TWARDUS 80)
40	230(TWARDUS 80)
50	280(TWARDUS 80)
60	335(TWARDUS 80)
70	370(TWARDUS 80)
80	380(TWARDUS 80)
90	385(TWARDUS 80)

11.0 EMULSION FORMATION TENDENCY & STABILITY:

12.0 WEATHERING:

13.0 SPREADING COEFFICIENT ON SEAWATER (mN/m or dynes/cm):

14.0 OTHERS:

14.1 IN-SITU COMBUSTION OF FRESH OIL: EASILY IGNITED, 6.1 WT % RESIDUE(TWARDUS 80)

14.2 FIRE POINT (DEG C): 10(O.C.)(TWARDUS 80)

14.3 PARAFFINS (WT %):

WEATHERING (WT %)	PARAFFINS (WT %)
0	70.6(MACKAY 82A)
10	82.5(MACKAY 82A)
20	80.8(MACKAY 82A)

14.4 AROMATICS (WT %):

WEATHERING (WT %)	AROMATICS (WT %)
0	21.0(MACKAY 82A)
10	11.9(MACKAY 82A)
20	12.8(MACKAY 82A)

14.5 WAX (WT %):

WEATHERING (WT %)	WAX (WT %)
0	2.18(MACKAY 82A)
10	3.02(MACKAY 82A)
20	3.41(MACKAY 82A)

14.6 ASPHALTENES (WT %):

WEATHERING (WT %)	ASPHALTENES (WT %)
0	3.78(MACKAY 82A)
10	3.20(MACKAY 82A)
20	3.62(MACKAY 82A)

COMPREHENSIVE DATA - SWEET MIXED BLEND CRUDE OIL

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1.0 TYPE: SWEET MIXED BLEND CRUDE OIL (EPS STANDARD OIL FOR DISPERSANT TESTING). TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml):

DEN = 0.847 + 0.00168 Fv - 0.001 T

where: DEN is density of oil at T and Fv (g/ml)
Fv is volume fraction of oil weathered
T is oil temperature (deg C)

TEMP (DEG C)	WEATHERING (VOL %) 0	14.8	25.5
0	0.847(EETD 84)	0.874(EETD 84)	0.888(EETD 84)
15	0.839(EETD 84)	0.868(EETD 84)	0.883(EETD 84)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%) 0	..	..
15	9.2(EETD 84)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (%) 0	..	..
15	11(EETD 84)		

COMPREHENSIVE DATA - SWEET MIXED BLEND CRUDE OIL
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6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (VOL %) 0	14.8	25.5
0		N/M(EETD 84)	N/M(EETD 84)
15	25.6(EETD 84)	28.1(EETD 84)	29.4(EETD 84)

6.2 OIL-SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (VOL %) 0	14.8	25.5
0		N/M(EETD 84)	N/M(EETD 84)
15	8.4(EETD 84)	8.6(EETD 84)	15.5(EETD 84)

6.3 OIL-WATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (VOL %) 0	14.8	25.5
15	21.5(EETD 84)	23.8(EETD 84)	21.1(EETD 84)

7.0 POUR POINT (DEG C):

8.0 FLASH POINT (DEG C): 7(C.C.)(EETD 84)

9.0 VAPOUR PRESSURE (kPa): 18.6(EETD 84)

10.0 ASTM DISTILLATION DATA:

11.0 EMULSION FORMATION TENDENCY & STABILITY:

11.1 EMULSION FORMATION TENDENCY:

	WEATHERING (VOL %)		
TEMP (DEG C)	0	14.8	25.5
0	1.0(EETD 84)	1.0(EETD 84)	1.0(EETD 84)
15	0(EETD 84)	0(EETD 84)	1.0(EETD 84)

11.2 EMULSION STABILITY:

	WEATHERING (VOL %)		
TEMP (DEG C)	0	14.8	25.5
0	1.0(EETD 84)	1.0(EETD 84)	1.0(EETD 84)
15	0.2(EETD 84)	0.2(EETD 84)	1.0(EETD 84)

11.3 WATER CONTENT OF STABLE EMULSION (VOL %):

	WEATHERING (VOL %)		
TEMP (DEG C)	0	14.8	25.5
0	46.7(EETD 84)	90.0(EETD 84)	88.9(EETD 84)
15	N/A(EETD 84)	N/A(EETD 84)	90(EETD 84)

12.0 WEATHERING:

$$Fv = \frac{\ln(1 + 3839.8\ \theta\ \exp(6.3 - 5096.4/TK)/TK)}{(3839.8/TK)}$$

where: Fv is fraction of oil weathered by volume
ln is natural log
θ is evaporation exposure
exp is exponential base e
TK is environmental temperature
(Kelvin, K = deg C + 273)

(EETD 84)

13.0 SPREADING COEFFICIENT ON SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (VOL %) 0	14.8	25.5
0		<0(EETD 84)	<0(EETD 84)
15	35.2(EETD 84)	32.5(EETD 84)	24.3(EETD 84)

COMPREHENSIVE DATA - TARSIUT CRUDE OIL

PAGE 1

1.0 TYPE: TARSIUT CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 23.3 TO 30.2(GULF 83); 28.0(DOME 84)

4.0 DENSITY (g/ml):

TEMP	WEATHERING (%)		
(DEG C)	0	..	..
0	0.884(EETD 84)		
15	0.875(EETD 84) 0.895(GULF 83)		
15.6	0.8868(DOME 84)		

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP	WEATHERING (%)		
(DEG C)	0	..	..
0	12.3(EETD 84)		
15	7.4(EETD 84)		
20	7.148(DOME 84)		
30	5.386(DOME 84)		
40	4.141(DOME 84)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP	WEATHERING (%)		
(DEG C)	0	..	..
0	13.9(EETD 84)		
15	8.5(EETD 84)		

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm):

	WEATHERING (%)		
TEMP (DEG C)	0	..	..
0	28.0(EETD 84)		
15	26.5(EETD 84)		

6.2 OIL-SEAWATER (mN/m or dynes/cm):

	WEATHERING (%)		
TEMP (DEG C)	0	..	..
0	5.3(EETD 84)		
15	9.5(EETD 84)		

6.3 OIL-WATER (mN/m or dynes/cm):

	WEATHERING (%)		
TEMP (DEG C)	0	..	..
0	20.0(EETD 84)		
15	20.0(EETD 84)		

7.0 POUR POINT (DEG C): <-61(GULF 83); <-60(DOME 84)

8.0 FLASH POINT (DEG C): 65(C.C.)(EETD 84)

9.0 VAPOUR PRESSURE (kPa): 0.8(EETD 84)

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
0	82 TO 138(GULF 83)
10	168 TO 198(GULF 83)
30	227 TO 253(GULF 83)
50	274 TO 306(GULF 83)
70	334 TO 371(GULF 83)
90	431 TO 457(GULF 83)
FINAL	567 TO 610(GULF 83)

11.0 EMULSION FORMATION TENDENCY & STABILITY:

11.1 EMULSION FORMATION TENDENCY:

TEMP (DEG C)	WEATHERING (VOL %)		
	0	12.0	..
0	0(EETD 84)		
15	0(EETD 84)	0(EETD 84)	

11.2 EMULSION STABILITY:

TEMP (DEG C)	WEATHERING (VOL %)		
	0	12.0	..
0	0(EETD 84)		
15	0(EETD 84)	0(EETD 84)	

11.3 WATER CONTENT OF STABLE EMULSION (VOL %):

TEMP (DEG C)	WEATHERING (VOL %)		
	0	12.0	..
0	N/A(EETD 84)		
15	N/A(EETD 84)	N/A(EETD 84)	

12.0 WEATHERING:

$$Fv = \frac{\ln(1 + 4727.7\, \theta\, \exp(6.3 - 4815.3/TK)/TK)}{(4727.7/TK)}$$

where: Fv is fraction of oil weathered by volume
ln is natural log
θ is evaporation exposure
exp is exponential base e
TK is environmental temperature
(Kelvin, K = deg C + 273)

(EETD 84)

13.0 SPREADING COEFFICIENT ON SEAWATER (mN/m or dynes/cm):

TEMP		WEATHERING	
		(%)	
(DEG C)	0	..	..
0	37.9(EETD 84)		
15	33.2(EETD 84)		

14.0 OTHERS:

14.1 CARBON RESIDUE (WT %): 36(GULF 83)

14.2 SULPHUR (WT %): 0.09 TO 0.15(GULF 83)

14.3 METALS (PPM): NICKEL: 0.5(GULF 83),
VANADIUM: 0.34(GULF 83),
COPPER: 1.57(GULF 83),
IRON: 9.57(GULF 83)

COMPREHENSIVE DATA - TRANSMOUNTAIN BLEND CRUDE OIL

1.0 TYPE: TRANSMOUNTAIN BLEND CRUDE OIL. TYPICAL DATA

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	0.865(EETD 84)		
15	0.855(EETD 84)		

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
15	10.5(EETD 84)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
15	12.3(EETD 84)		

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
15	25.0(EETD 84)		

6.2 OIL-SEAWATER (mN/m or dynes/cm):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
15	19.3(EETD 84)		

7.0 POUR POINT (DEG C):

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa): 45.7(EETD 84)

10.0 ASTM DISTILLATION DATA:

11.0 EMULSION FORMATION TENDENCY & STABILITY:

11.1 EMULSION FORMATION TENDENCY:

TEMP		WEATHERING (%)	
(DEG C)	0	..	..
15	0.2(EETD 84)		

11.2 EMULSION STABILITY:

TEMP		WEATHERING (%)	
(DEG C)	0	..	..
15	0.1(EETD 84)		

11.3 WATER CONTENT OF STABLE EMULSION (%):

TEMP		WEATHERING (%)	
(DEG C)	0	..	..
15	N/A(EETD 84)		

12.0 WEATHERING:

$$Fv = \frac{\ln(1 + 6488\ \theta\ \exp(6.3 - 3924.3/TK)/TK)}{(6488/TK)}$$

where: Fv is fraction of oil weathered by volume
ln is natural log
θ is evaporation exposure
exp is exponential base e
TK is environmental temperature
(Kelvin, K = deg C + 273)

(EETD 84)

```
13.0 SPREADING COEFFICIENT ON SEAWATER (mN/m or dynes/cm):
                                 WEATHERING
TEMP                             (    %)
(DEG C)   0                         ..                    ..
------   ----------------------------------------------------
  15      24.8
-------------------------------------------------------------
```

5.2 Standard Assay Data

- Alaska North Slope Cride Oil
- Alberta Crude Oil
- Arabian Crude Oil
- Atkinson Crude Oil
- Auk Crude Oil
- Bow River Blend Crude Oil
- Cold Lake Crude Oil
- Ekofisk Crude Oil
- Federated Light and Medium Crude Oil
- Forties Crude Oil
- Fuel Oil Number 1 (Kerosene)
- Fuel Oil Number 1 (J.P.-1)
- Fuel Oil Number 1 (J.P.-4)
- Fuel Oil Number 1 (J.P.-6)
- Fuel Oil Number 4
- Fuel Oil Number 5
- Gulf Alberta Light and Medium Crude Oil
- Hi-Aromatic Heating Oil
- Issungnak Crude Oil
- Koakoak 0-22 Crude Oil
- Koakoak 0-22A Crude Oil
- Kopanoar Crude Oil
- Kopanoar 2I-44 Crude Oil
- Kopanoar M-13 Crude Oil
- Kopanoar M-13A Crude Oil

5.2 Standard assay Data Cont'd

- Kuparuk Crude Oil
- Kuwait Crude Oil
- La Rosa Crude Oil
- Lloydminster Crude Oil
- Lloydminster Crude Oil 2
- Mayogiak Crude Oil
- Murban Crude Oil
- Nektoralik K-59 Crude Oil
- Nektoralik K-59A Crude Oil
- Nerlerk M-98A Crude Oil
- Nerlerk M-98B Crude Oil
- Nerlerk M-98C Crude Oil
- Ninian Crude Oil
- North Slope Crude Oil
- Piper Crude Oil
- Rainbow Light and Medium Crude Oil
- Rangeland - South Light and Medium Crude Oil
- South Louisiana Crude Oil
- Tarsiut A-25 Crude Oil
- Typical Heating Oil
- Ukalerk 2C-50 Crude Oil
- Wainwright - Kinsella Crude Oil
- Weyburn - Midale Crude Oil

STANDARD ASSAY DATA - ALASKA NORTH SLOPE CRUDE OIL
PAGE 1

1.0 TYPE: ALASKA NORTH SLOPE CRUDE OIL (ANS, SUDLEROCHIT).
TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 26.4(AALUND 83)

4.0 DENSITY (g/ml): @ 21 DEG C, 0.8954(AALUND 83)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt): @ 15.6 DEG C,
42.42(AALUND 83)

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -17.8(AALUND 83)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa): 24.495(AALUND 83)

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 SULFUR (WT %): 1.06(AALUND 83)

11.2 CARBON RESIDUE (WT %): 4.40(AALUND 83)

11.3 METALS (PPM): NICKEL: 11(AALUND 83)
VANADIUM: 26(AALUND 83)

11.4 NITROGEN (PPM): 2,090(AALUND 83)

11.5 H_2S (mg/m^3): 25.27(AALUND 83)

11.6 SALT (g/m^3): 2.3606(AALUND 83)

STANDARD ASSAY DATA - ALBERTA CRUDE OIL
PAGE 1

1.0 TYPE: ALBERTA CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml):

TEMP (DEG C)	WEATHERING (WT %)		
	0	10	20
0	0.850 (MACKAY 82A)		
5	0.846 (MACKAY 82A)		
10	0.843 (MACKAY 82A)		
15	0.840 (MACKAY 82A)		
20	0.835 (MACKAY 82A)	0.855 (MACKAY 82A)	0.866 (MACKAY 82A)
25	0.832 (MACKAY 82A) 0.83 (MACKAY 82A)		

NOTE: DEN = 0.850 - 0.00072T
WHERE: DEN IS THE DENSITY OF FRESH OIL AT T (g/ml)
T IS OIL TEMPERATURE DEG C (MACKAY 82A)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)		WEATHERING (%)	
	0	..	..
0	17.6(MACKAY 82A)		
5	12.4(MACKAY 82A)		
10	9.03(MACKAY 82A)		
15	6.43(MACKAY 82A)		
20	4.98(MACKAY 82A)		
25	4.22(MACKAY 82A)		

NOTE: VISC = EXP((4760/(T+273)) - 14.6)
WHERE: VISC IS VISCOSITY OF FRESH OIL AT T (mPa.s)
T IS OIL TEMPERATURE (DEG C) (MACKAY 82A)

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)		WEATHERING (%)	
	0	..	..
0	20.7(MACKAY 82A)		
5	14.7(MACKAY 82A)		
10	10.71(MACKAY 82A)		
15	7.65(MACKAY 82A)		
20	5.96(MACKAY 82A)		
25	5.08(MACKAY 82A)		

6.0 INTERFACIAL TENSIONS:

STANDARD ASSAY DATA - ALBERTA CRUDE OIL

7.0 POUR POINT (DEG C):

WEATHERING (WT %)	POUR POINT (DEG C)
0	-24(MACKAY 82A)
10	12(MACKAY 82A)
20	15(MACKAY 82A)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

TEMP (DEG C)	VAPOUR PRESSURE (kPa)
63	35.7(MACKAY 74)
15.6	66.9(MACKAY 74)

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
10	120(MACKAY 74)
25	187(MACKAY 74)
40	254(MACKAY 74)

11.0 OTHERS:

11.1 PARAFFINS (WT %):

WEATHERING (WT %)	PARAFFINS (WT %)
0	78.3(MACKAY 82A)
10	80.3(MACKAY 82A)
20	77(MACKAY 82A)

11.2 AROMATICS (WT %):

WEATHERING (WT %)	AROMATICS (WT %)
0	17.3(MACKAY 82A)
10	13.0(MACKAY 82A)
20	15.2(MACKAY 82A)

11.3 ASPHALTENES (WT %):

WEATHERING (WT %)	ASPHALTENES (WT %)
0	1.21(MACKAY 82A)
10	3.69(MACKAY 82A)
20	4.12(MACKAY 82A)

STANDARD ASSAY DATA - ARABIAN CRUDE OIL

1.0 TYPE: ARABIAN CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 32.5(API 81)

4.0 DENSITY (g/ml): @ 15.6 DEG C, 0.862(API 81)

5.0 VISCOSITY:

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C):

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

STANDARD ASSAY DATA - ARABIAN CRUDE OIL

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
IBP	29(API 81)
5	69(API 81)
10	100(API 81)
15	128(API 81)
20	151(API 81)
25	172(API 81)
30	198(API 81)
35	213(API 81)
40	238(API 81)
45	261(API 81)
50	282(API 81)
55	304(API 81)
60	329(API 81)
65	351(API 81)
70	373(API 81)
75	398(API 81)
80	422(API 81)
85	448(API 81)
90	475(API 81)
95	504(API 81)
FBP	537(API 81)

NOTE: (API 81) DATA FROM SIMULATED DISTILLATION METHOD
ASTM D 2887

11.0 OTHERS:

11.1 SULFUR (WT %): 1.87(API 81)

11.2 NITROGEN (WT %): 0.088(API 81)

11.3 METALS (PPM): NICKEL: 14(API 81)
VANADIUM: 3.7(API 81)

STANDARD ASSAY DATA - ATKINSON CRUDE OIL
PAGE 1

1.0 TYPE: ATKINSON CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml):

TEMP (DEG C)	WEATHERING (%) 0	4	12
15	0.911(EETD 84)		
20	0.9060(ESSO 83)	0.9172(ESSO 83)	0.9239(ESSO 83)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (%) 0	4	12
-10	304.8(ESSO 83)	762.7(ESSO 83)	2506(ESSO 83)
0	136.2(ESSO 83)	317.0(ESSO83)	783.7(ESSO 83)
15	57.28(ESSO 83)	113.6(ESSO 83)	245.0(ESSO 83)
25	34.94(ESSO 83)	62.05(ESSO 83)	124.4(ESSO 83)

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C):

WEATHERING (%)	POUR POINT (DEG C)
0	-38(ESSO 83)
4	-35(ESSO 83)
12	-28(ESSO 83)

8.0 FLASH POINT (DEG C):

WEATHERING (%)	FLASH POINT (DEG C)
0	10(ESSO 83)
4	32(ESSO 83)
12	75(ESSO 83)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA (DEG C):

PERCENT CONDENSED (VOL %)	WEATHERING (%)		
	0	4	12
INITIAL	40(ESSO 83)	88(ESSO 83)	131(ESSO 83)
50	372(ESSO 83)	383(ESSO 83)	404(ESSO 83)
FINAL	555(ESSO 83)	553(ESSO 83)	556(ESSO 83)
FINAL VOL CONT'D	81 %(ESSO 83)	79 %(ESSO 83)	77 %(ESSO 83)

11.0 OTHERS:

11.1 FIRE POINT:

WEATHERING (%)	FIRE POINT (DEG C)
0	26(ESSO 83)
4	50.5(ESSO 83)
12	95(ESSO 83)

STANDARD ASSAY DATA - AUK CRUDE OIL
PAGE 1

1.0 TYPE: AUK CRUDE OIL SHELL/ESSO. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 37.5(HMSO 76)

4.0 DENSITY (g/ml): @ 15 DEG C, 0.837(HMSO 76)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt): @ 15 DEG C, 3.65(HMSO 76)

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -1 (-10)(HMSO 76)

NOTE: FIGURES IN BRACKETS ARE OBTAINED FROM THE OIL INDUSTRY AND ARE THOSE WHICH DONOT AGREE WITH THE PUBLISHED DATA. (HMSO 76)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

WEIGHT PERCENT	TEMP (DEG C)
9.5	5 TO 100(HMSO 76)
10.6	100 TO 160(HMSO 76)
16.6	160 TO 250(HMSO 76)
18.8	250 TO 350(HMSO 76)
44.5	>350(HMSO 76)

11.0 OTHERS:

11.1 SULFUR (WT %): 0.4(HMSO 76)

11.2 WAX (WT %): 7(HMSO 76)

STANDARD ASSAY DATA - BOW RIVER BLENDED CRUDE OIL
PAGE 1

1.0 TYPE: BOW RIVER BLENDED CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 26.7(AALUND 83A)

4.0 DENSITY (g/ml):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	0.900(MACKAY 82A)		
5	0.899(MACKAY 82A)		
10	0.896(MACKAY 82A)		
15	0.893(MACKAY 82A)		
15.5	0.8936(AALUND 83A)		
20	0.889(MACKAY 82A)		
25	0.885(MACKAY 82A)		

NOTES: DEN = 0.901 - 0.000617 T
WHERE: DEN IS THE DENSITY OF FRESH OIL AT T (mPa.s)
T IS OIL TEMPERATURE (DEG C) (MACKAY 82A)

0.923 @ 10 WT% WEATHERING & 0.938 @ 20 WT% WEATHERING(MACKAY 82A)

0.90 @ ROOM TEMP(TWARDUS 80)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP	WEATHERING (%)		
(DEG C)	0	..	..
0	88.4(MACKAY 82A) 74(TWARDUS 80)		
5	62.0(MACKAY 82A)		
10	45.1(MACKAY 82A) 67(TWARDUS 80)		
15	33.7 (MACKAY 82A)		
20	28.3(MACKAY 82A) 42.5(TWARDUS 80)		
25	23.7(MACKAY 82A)		

NOTES: VISC = EXP((4310/(T+273))-11.4)
WHERE: VISC IS VISCOSITY OF FRESH OIL AT T (mPa.s)
T IS TEMP (DEG C) (MACKAY 82A)

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP	WEATHERING (%)		
(DEG C)	0	..	..
0	98.2(MACKAY 82A)		
5	69.0(MACKAY 82A)		
10	50.3(MACKAY 82A)		
15	37.7(MACKAY 82A)		
20	31.8(MACKAY 82A)		
25	26.8(MACKAY 82A)		
40	18.30(AALUND 83A)		

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm): 15 @ ROOM TEMP(TWARDUS 80)

6.2 OIL-WATER (mN/m or dynes/cm): 28.95 @ ROOM TEMP (TWARDUS 80)

6.3 OIL-SEAWATER (mN/m or dynes/cm): USING 3% NaCl IN TAP WATER: 26.8 ; 23.9 @ 10 WT% WEATHERING & 27.8 @ 20 WT% WEATHERING (MACKAY 82A)

7.0 POUR POINT (DEG C):

WEATHERING (WT %)	POUR POINT (DEG C)
0	-39(MACKAY 82A) -27(TWARDUS 80) -50.5(AALUND 83A)
10	-15(MACKAY 82A)
20	-3(MACKAY 82A)

8.0 FLASH POINT (DEG C): <12(O.C.)(TWARDUS 80)

9.0 VAPOUR PRESSURE (kPa): 37.2(AALUND 83A)

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
0	45.95(TWARDUS 80)
10	115(TWARDUS 80)
20	185(TWARDUS 80)
30	265(TWARDUS 80)
40	310(TWARDUS 80)
50	350(TWARDUS 80)
60	370(TWARDUS 80)
70	385(TWARDUS 80)
80	390(TWARDUS 80)

11.0 OTHERS:

11.1 IN-SITU COMBUSTION RESULTS - FRESH OIL IGNITED EASILY, RESIDUE 6.1 VOL% (TWARDUS 80)

11.2 FIRE POINT (DEG C): 22(TWARDUS 80)

11.3 PARAFFINS (WT %):

WEATHERING (WT %)	PARAFFINS (WT %)
0	69.6(MACKAY 82A)
10	66.7(MACKAY 82A)
20	62.5(MACKAY 82A)

11.4 AROMATICS (WT %):

WEATHERING (WT %)	AROMATICS (WT %)
0	21.4(MACKAY 82A)
10	22.4(MACKAY 82A)
20	25.8(MACKAY 82A)

11.5 WAX (WT %):

WEATHERING (WT %)	WAX (WT %)
0	2.75(MACKAY 82A)
10	6.47(MACKAY 82A)
20	8.63(MACKAY 82A)

11.6 ASPHALTENES (WT %):

WEATHERING (WT %)	ASPHALTENES (WT %)
0	5.04(MACKAY 82A)
10	6.47(MACKAY 82A)
20	8.63(MACKAY 82A)

11.7 SULFUR (PPM): 21,000(AALUND 83A)

11.8 CON. CARBON (WT %): 6.7(AALUND 83A)

11.9 METALS (PPM): NICKEL: 20.7(AALUND 83A)
VANADIUM: 54.0(AALUND 83A)

STANDARD ASSAY DATA - COLD LAKE CRUDE OIL

PAGE 1

1.0 TYPE: COLD LAKE CRUDE OIL, ALBERTA. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml): @ ? TEMP , 0.9031(AALUND 83A)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt): @ 15 DEG C, 70.7 (AALUND 83A)

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -60(AALUND 83A)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 SULFUR (WT %): 2.91(AALUND 83A)

11.2 NITROGEN (WT %): 0.29(AALUND 83A)

STANDARD ASSAY DATA - EKOFISK CRUDE OIL

1.0 TYPE: EKOFISK CRUDE OIL, PHILLIPS. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 35.6(HMSO 76)

4.0 DENSITY (g/ml): @ 15 DEG C, 0.847(HMSO 76)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt): @ 50 DEG C, 4.25(HMSO 76)

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -5 (-12)(HMSO 76)

NOTE: FIGURES IN BRACKETS ARE OBTAINED FROM THE OIL INDUSTRY AND ARE THOSE WHICH DONOT AGREE WITH THE PUBLISHED DATA. (HMSO 76)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

WEIGHT PERCENT	TEMP (DEG C)
7	5 TO 100(HMSO 76),(CORM 78)
11.1	100 TO 160(HMSO 76),(CORM 78)
15.1	160 TO 250(HMSO 76),(CORM 78)
19	250 TO 350(HMSO 76),(CORM 78)
47.8	>350(HMSO 76),(CORM 78)

11.0 OTHERS:

11.1 SULFUR (WT %): 0.18(HMSO 76)

11.2 WAX (WT %): 6.5(HMSO 76)

11.3 ASPHALTENES (WT %): 0.03(CORM 78)

STANDARD ASSAY DATA - FEDERATED L & M CRUDE OIL

1.0 TYPE: FEDERATED LIGHT AND MEDIUM CRUDE OIL, ALBERTA.
TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 39.7(AALUND 83A)

4.0 DENSITY (g/ml): @ 21 DEG C, 0.8258(AALUND 83A)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt): @ 40 DEG C,
42.42(AALUND 83A)

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -10.0(AALUND 83A)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa): 31.0(AALUND 83A)

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 SULFUR (PPM): 2,010(AALUND 83A)

11.2 CARBON RESIDUE (WT %): 1.46(AALUND 83A)

11.3 METALS (PPM): NICKEL: 0.07(AALUND 83A)
VANADIUM: 0.00(AALUND 83A)

11.4 NITROGEN (WT %): 0.11(AALUND 83A)

11.5 WAX (WT %): 9.12(AALUND 83A)

STANDARD ASSAY DATA - FORTIES CRUDE OIL
PAGE 1

1.0 TYPE: FORTIES CRUDE OIL, BP. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 37.35(HMSO 76), 37.4 (LYNCH 81)

4.0 DENSITY (g/ml): @ 15 DEG C, 0.838(HMSO 76)
@ 16 DEG C, 0.8373(LYNCH 81)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt): @ 50 DEG C, 3.7(LYNCH 81); @ 50 DEG C, 3.7(HMSO 76)

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -1(HMSO 76); -3(LYNCH 81)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

WEIGHT PERCENT	TEMP (DEG C)
7.9	5 TO 100(HMSO 76),(LYNCH 81)
11.7	100 TO 160(HMSO 76),(LYNCH 81)
12.5	160 TO 250(HMSO 76),(LYNCH 81)
21.9	250 TO 350(HMSO 76),(LYNCH 81)
46.0	>350(HMSO 76),(LYNCH 81)

11.0 OTHERS:

11.1 SULFUR (WT %): 0.29(HMSO 76)

11.2 WAX (WT %): 9(HMSO 76); 9(LYNCH 81)

11.3 ASPHALTENES (WT %): 0.2 (IP METHOD 143/57)(LYNCH 81)

STANDARD ASSAY DATA - FUEL OIL # 1 (KEROSENE)
PAGE 1

1.0 TYPE: FUEL OIL # 1, KEROSENE. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml):

TEMP (DEG C)		WEATHERING (%)	
	0	..	..
0	0.837 TO 0.847(CURL 77)		
15	0.827 TO 0.850(CURL 77)		
20	0.823 TO 0.847(CURL 77)		

NOTE: DATA OBTAINED FROM A GRAPH

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)		WEATHERING (%)	
	0	..	..
0	3.1 TO 5.0(CURL 77)		
15	2.1 TO 3.5(CURL 77)		
20	1.9 TO 3.3(CURL 77)		

NOTE: DATA OBTAINED FROM A GRAPH

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -18(CURL 77)

8.0 FLASH POINT (DEG C): 38 TO 74(CURL 77)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 AUTO-IGNITION TEMPERATURE (DEG C): 229(CURL 77)

11.2 EXPLOSION LIMITS OF VAPOUR IN AIR:
UPPER: 5.0%(CURL 77)
LOWER: 0.7%(CURL 77)

11.3 BOILING RANGE (DEG C): 174 TO 266(CURL 77)

11.4 AROMATICS (WT %): 12(CURL 77)

11.5 PARAFFINS (WT %): 32(CURL 77)

11.6 NAPHTHENES (WT %): 56(CURL 77)

STANDARD ASSAY DATA - FUEL OIL # 1 (J.P.-1)

1.0 TYPE: FUEL OIL # 1 (JET FUEL, J.P.-1). TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml):

5.0 VISCOSITY:

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C):

8.0 FLASH POINT (DEG C): 35 TO 63(CURL 77)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 AUTO-IGNITION TEMPERATURE (DEG C): 229(CURL 77)

STANDARD ASSAY DATA - FUEL OIL # 1 (J.P.-4)

1.0 TYPE: FUEL OIL # 1 (JET FUEL, J.P.-4). 65% GASOLINE, 35% LIGHT PETROLEUM DISTILLATES(CURL 77) TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml): @ 15 DEG C, APPROX. 0.80(NAVAL 77)

5.0 VISCOSITY:

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C):

8.0 FLASH POINT (DEG C): -23 TO -1(CURL 77),
APPROX. -25(NAVAL 77)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 AUTO-IGNITION TEMPERATURE (DEG C): 242(CURL 77)

STANDARD ASSAY DATA - FUEL OIL # 1 (J.P.-5)
PAGE 1

1.0 TYPE: FUEL OIL # 1 (JET FUEL, J.P.-5). SPECIALLY REFINED KEROSENE (CURL 77).TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml): @ 15 DEG C, MAXIMUM 0.844(NAVAL 77)

5.0 VISCOSITY:

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C):

8.0 FLASH POINT (DEG C): 35 TO 63(CURL 77),
MINIMUM 60(NAVAL 77)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 AUTO-IGNITION TEMPERATURE (DEG C): 246(CURL 77)

STANDARD ASSAY DATA - FUEL OIL # 1 (J.P.-6)
PAGE 1

1.0 TYPE: FUEL OIL # 1 (JET FUEL, J.P.-6). A HIGHER KEROSENE CUT THAN J.P.-4 WITH FEWER IMPURITIES. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml):

5.0 VISCOSITY:

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C):

8.0 FLASH POINT (DEG C): 38(CURL 77)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 AUTO-IGNITION TEMPERATURE (DEG C): 224(CURL 77)

STANDARD ASSAY DATA - FUEL OIL NO. 4

1.0 TYPE: FUEL OIL NO. 4, CAN BE PREPARED FROM 40% FUEL OIL NO. 2 AND 60% FUEL OIL NO. 6, OR, MAY BE A HIGH-BOILING-DISTILLATE OR LIGHT RESIDUAL OF THE CRUDE OIL. (CURL 77). TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	0.914 TO 0.922 (CURL 77) 0.938 (MACKAY 82B)		
15	0.904 TO 0.912 (CURL 77)		
20	0.901 TO 0.909 (CURL 77) 0.925 (MACKAY 82B)		
30	0.895 TO 0.902 (CURL 77)		

NOTE: (CURL 77) DATA OBTAINED FROM A GRAPH

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
10	47.2 (MACKAY 82B)		
20	22.7 (MACKAY 82B)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	0	WEATHERING (%) ..	..
10	40 TO 101(CURL 77)		
15	33 TO 79(CURL 77)		
20	27 TO 60(CURL 77)		
30	18 TO 38(CURL 77)		
40	11 TO 26(CURL 77)		

NOTE: DATA OBTAINED FROM A GRAPH (CURL 77)

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm): @ 20 DEG C, 32.1 (MACKAY 82B)

6.2 OIL-SEAWATER (mN/m or dynes/cm): @ 20 DEG C, 30.23 (MACKAY 82B)

7.0 POUR POINT (DEG C): -7(CURL 77), -3(MACKAY 82B)

8.0 FLASH POINT (DEG C): 54(CURL 77), 78(MACKAY 82B)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 EMULSION FORMATION TENDENCY & STABILITY: FORMS STABLE EMULSION (MACKAY 82B)

11.2 AUTO-IGNITION TEMPERATURE (DEG C): 263(CURL 77)

11.3 AQUEOUS SOLUBILITY (mg/L): @ 20 DEG C, 6.46 (MACKAY 82B)

STANDARD ASSAY DATA - FUEL OIL NO. 5

1.0 TYPE: FUEL OIL NO. 5, NAVY SPECIAL OR BUNKER B. CAN BE PREPARED BY ADDING 20 TO 25% FUEL OIL NO. 2 TO 75 TO 80% FUEL OIL NO.6 (CURL 77) LIGHT FUEL OIL NO.5 AND HEAVY FUEL OIL NO.5 (CURL 77). TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: MINIMUM 11.5(NAVAL 77)

4.0 DENSITY (g/ml):

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	0.932 TO 0.957(CURL 77)		
15	0.923 TO 0.948(CURL 77)		
20	0.920 TO 0.945(CURL 77)		
30	0.913 TO 0.938(CURL 77)		

NOTE: DATA OBTAINED FROM A GRAPH (CURL 77)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	FUEL OIL # 5 LIGHT	FUEL OIL # 5 HEAVY
10	200 TO 473(CURL 77)	>473(CURL 77)
15	152 TO 313(CURL 77)	>313(CURL 77)
20	123 TO 233(CURL 77)	>233(CURL 77)
25	100 TO 165(CURL 77)	165 TO 327(CURL 77)
30	74 TO 125(CURL 77)	125 TO 200(CURL 77)
40	40 TO 75(CURL 77)	75 TO 100(CURL 77)

NOTE: DATA OBTAINED FROM A GRAPH (CURL 77)

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): MAXIMUM -9.4(NAVAL 77)

8.0 FLASH POINT (DEG C): >54(CURL 77), MINIMUM 60(NAVAL 77)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

STANDARD ASSAY DATA - GULF ALBERTA L & M CRUDE OIL

1.0 TYPE: GULF ALBERTA L & M CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 35.1(AALUND 83A)

4.0 DENSITY (g/ml): @ 21 DEG C, 0.8486(AALUND 83A)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt): @ 40 DEG C, 4.86 (AALUND 83A)

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -27.5(AALUND 83A)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa): 36.4 (AALUND 83A)

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 SULFUR (PPM): 9,800(AALUND 83A)

11.2 H2S (PPM): 58.1(AALUND 83A)

11.3 METALS (PPM): NICKEL: 10.10(AALUND 83)
VANADIUM: 9.00(AALUND 83)

STANDARD ASSAY DATA - HI-AROMATIC HEATING OIL

1.0 TYPE: HI-AROMATIC HEATING OIL

2.0 COLOUR:

3.0 API GRAVITY: 33.7(API 81)

4.0 DENSITY (g/ml): @ 15.6 DEG C, 0.8558(API 81)

5.0 VISCOSITY:

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C):

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

STANDARD ASSAY DATA - HI-AROMATIC HEATING OIL

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
IBP	138(API 81)
5	181(API 81)
10	199(API 81)
15	210(API 81)
20	219(API 81)
25	227(API 81)
30	235(API 81)
35	245(API 81)
40	253(API 81)
45	261(API 81)
50	269(API 81)
55	275(API 81)
60	282(API 81)
65	288(API 81)
70	297(API 81)
75	305(API 81)
80	316(API 81)
85	325(API 81)
90	336(API 81)
95	352(API 81)
FBP	387(API 81)

NOTE: (API 81) DATA FROM SIMULATED DISTILLATION ASTM METHOD D 2887

STANDARD ASSAY DATA - HI-AROMATIC HEATING OIL

11.0 OTHERS:

11.1 SULFUR (WT %): 0.12(API 81)

11.2 NITROGEN (WT %): 0.009(API 81)

11.3 METALS (PPM): NICKEL: 0.1(API 81)
VANADIUM: 0.1 TO 0.3(API 81)

STANDARD ASSAY DATA - ISSUNGNAK CRUDE OIL
PAGE 1

1.0 TYPE: ISSUNGNAK CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml):

TEMP (DEG C)	WEATHERING (%) 0	4	12
15	0.849(EETD 84)		
20	0.8284(ESSO 83)	0.8459(ESSO 83)	0.8469(ESSO 83)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (%) 0	4	12
-10	DNF(ESSO 83)	DNF(ESSO 83)	DNF(ESSO 83)
0	199.4(ESSO 83)	DNF(ESSO 83)	DNF(ESSO 83)
15	3.652(ESSO 83)	6.008(ESSO 83)	6.248(ESSO 83)
25	3.005(ESSO 83)	4.564(ESSO 83)	4.566(ESSO 83)

NOTE: DNF = DID NOT FLOW

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C):

WEATHERING (%)	POUR POINT (DEG C)
0	5(ESSO 83)
4	6(ESSO 83)
12	7(ESSO 83)

STANDARD ASSAY DATA - ISSUNGNAK CRUDE OIL

8.0 FLASH POINT (DEG C):

WEATHERING (%)	FLASH POINT (DEG C)
0	-10(ESSO 83)
4	-16(ESSO 83)
12	48(ESSO 83)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	WEATHERING (%) 0	4	12
INITIAL	-5(ESSO 83)	38(ESSO 83)	83(ESSO 83)
50	254(ESSO 83)	276(ESSO 83)	283(ESSO 83)
FINAL	448(ESSO 83)	544(ESSO 83)	538(ESSO 83)
FINAL VOL CONT'D	100 %(ESSO 83)	96 %(ESSO 83)	98 %(ESSO 83)

11.0 OTHERS:

11.1 FIRE POINT (DEG C):

WEATHERING (%)	FIRE POINT (DEG C)
0	-10(ENGELHARDT 84)
4	-16(ENGELHARDT 84)
12	57(ENGELHARDT 84)

STANDARD ASSAY DATA - KOAKOAK O-22 CRUDE OIL

1.0 TYPE: KOAKOAK O-22 CRUDE OIL, BEAUFORT SEA.
TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 28.1(DOME 84)

4.0 DENSITY (g/ml): @ 21 DEG C, 0.8858(DOME 84);
@ 15.6 DEG C, 0.8887(DOME 84)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%) 0	..	..
20	19.98(DOME 84)		
30	12.91(DOME 84)		
40	8.890(DOME 84)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -48(DOME 84)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

STANDARD ASSAY DATA - KOAKOAK O-22A CRUDE OIL
PAGE 1

1.0 TYPE: KOAKOAK O-22A CRUDE OIL, BEAUFORT SEA.
TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 29.5(DOME 84)

4.0 DENSITY (g/ml): @ 15.6 DEG C, 0.8785(DOME 84)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%) 0	..	..
20	10.323(DOME 84)		
30	6.836(DOME 84)		
40	5.022(DOME 84)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): <60(DOME 84)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

STANDARD ASSAY DATA - KOPANOAR CRUDE OIL
PAGE 1

1.0 TYPE: KOPANOAR CRUDE OIL, BEAUFORT SEA. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 25.7(ENGELHARDT 84)

4.0 DENSITY (g/ml):

TEMP (DEG C)	WEATHERING (WT %) 0	3.7	11.6
16	0.8992 (ENGELHARDT 84)	0.9002 (ENGELHARDT 84)	0.9012 (ENGELHARDT 84)
20	0.900 (MACKAY 80A)	0.901 (MACKAY 80A)	0.902 (MACKAY 80A)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%) 0	3.7	11	11.6
-20	117.3 (MACKAY 80A)		323.8 (MACKAY 80A)	
-10	78 (MACKAY 80A)		210.3 (MACKAY 80A)	
0	57 (ENGEL 84) 41 (MACKAY 80A)	75 (ENGEL 84)	92.8 (MACKAY 80A)	104 (ENGEL 84)
10	19.2 (MACKAY 80A)		40.0 (MACKAY 80A)	
15	33 (ENGEL 84)	41 (ENGEL 84)		54 (ENGEL 84)
22	10.5 (MACKAY 80A)		19.1 (MACKAY 80A)	
25	17.5 (ENGEL 84)	24 (ENGEL 84)		30 (ENGEL 84)

NOTE: (ENGEL 84) REFERS TO (ENGELHARDT 84)

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C):

WEATHERING (WT %)	POUR POINT (DEG C)
0	-37 (ENGELHARDT 84)
3.7	-28 (ENGELHARDT 84)
11.6	-19 (ENGELHARDT 84)

8.0 FLASH POINT (DEG C):

WEATHERING (WT %)	POUR POINT (DEG C)
0	75 (ENGELHARDT 84)
3.7	86 (ENGELHARDT 84)
11.6	118 (ENGELHARDT 84)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 INITIAL BOILING POINT (DEG C): 84 (MACKAY 80A)

11.2 FIRE POINT (DEG C):

WEATHERING (WT %)	FIRE POINT (DEG C)
0	85 (MACKAY 80A)
3.7	98 (MACKAY 80A)
11.6	125 (MACKAY 80A)

STANDARD ASSAY DATA - KOPANOAR CRUDE OIL

11.3 AQUEOUS SOLUBILITY (mg/L):

WEATHERING (WT %)	AQUEOUS SOLUBILITY (mg/L)
0	10.4(MACKAY 80A)
3.7	8.6(MACKAY 80A)
11.6	3.0(MACKAY 8CA)

STANDARD ASSAY DATA - KOPANOAR 2I-44 CRUDE OIL
PAGE 1

1.0 TYPE: KOPANOAR 2I-44 CRUDE OIL, BEAUFORT SEA.
TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 29.3(DOME 84)

4.0 DENSITY (g/ml): @ 15.6 DEG C, 0.8685(DOME 84)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

		WEATHERING (%)	
TEMP (DEG C)	0	..	..
20	12.60(DOME 84)		
30	8.87(DOME 84)		
40	6.774(DOME 84)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -21.6(DOME 84)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

STANDARD ASSAY DATA - KOPANOAR M-13 CRUDE OIL
PAGE 1

1.0 TYPE: KOPANOAR M-13 CRUDE OIL, BEAUFORT SEA.
TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 30.9(DOME 84)

4.0 DENSITY (g/ml): @ 15.6 DEG C, 0.8939(DOME 84)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

	WEATHERING (%)		
TEMP (DEG C)	0	..	..
10	61.4(DOME 84)		
20	33.97(DOME 84)		
30	21.67(DOME 84)		
40	14.38(DOME 84)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): 2.7(DOME 84)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

STANDARD ASSAY DATA - KOPANOAR M-13A CRUDE OIL

1.0 TYPE: KOPANOAR M-13A CRUDE OIL, BEAUFORT SEA.
TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 26.7(DOME 84)

4.0 DENSITY (g/ml): @ 21 DEG C, 0.8938(DOME 84)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	219.8(DOME 84)		
4.4	128.0(DOME 84)		
10	74.85(DOME 84)		
15.4	43.21(DOME 84)		
20	40.12(DOME 84)		
30	28.46(DOME 84)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -17.5(DOME 84)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 WAX (WT %): 0.22(DOME 84)

STANDARD ASSAY DATA - KUPARUK CRUDE OIL
PAGE 1

1.0 TYPE: KUPARUK CRUDE OIL, ALASKA. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 23.0(AALUND 83)

4.0 DENSITY (g/ml): @ 21 DEG C, 0.9150(AALUND 83)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt): @ 15.6 DEG C,
79.98(AALUND 83)

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -48.3(AALUND 83)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa): 17.94(AALUND 83)

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 CARBON RESIDUE (WT %): 7.37(AALUND 83)

11.2 METALS (PPM): NICKEL: 19(AALUND 83)
VANADIUM: 57(AALUND 83)

11.3 NITROGEN (PPM): 1,980(AALUND 83)

11.4 $H2S$ (mg/m^3): <361(AALUND 83)

STANDARD ASSAY DATA - KUWAIT CRUDE OIL
PAGE 1

1.0 TYPE: KUWAIT CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 31.1(LYNCH 81), 31.1(HMSO 76), 31.4(PANCIROV 74)

4.0 DENSITY (g/ml):

TEMP (DEG C)		WEATHERING (%)	
	0	9	38.1
16	0.8692(LYNCH 81)	0.895(CURL 77)	0.955(CURL 77)
15	0.870(HMSO 76)		

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)			WEATHERING (WT %)		
	0	15.1	19.5	26.7	33.0
10 (LYNCH 81)	19	97	163	865	2279

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt): @ 50 DEG C, 7.6 (HMSO 76),(LYNCH 81)

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -20(LYNCH 81),(HMSO 76)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

STANDARD ASSAY DATA - KUWAIT CRUDE OIL
PAGE 2

10.0 ASTM DISTILLATION DATA:

WEIGHT PERCENT	TEMP (DEG C)
8.3	5 TO 100(LYNCH 81),(HMSO 76)
9.1	100 TO 160(LYNCH 81),(HMSO 76)
12.4	160 TO 250(LYNCH 81),(HMSO 76)
16.0	250 TO 350(LYNCH 81),(HMSO 76)
54.2	>350(LYNCH 81),(HMSO 76)

11.0 OTHERS:

11.1 SULFUR (WT %): 2.44(PANCIROV 74); 2.53(HMSO 76)

11.2 NITROGEN (WT %): 0.14(PANCIROV 74)

11.3 METALS (PPM): NICKEL: 7.7(PANCIROV 74)
VANADIUM: 28(PANCIROV 74)

11.4 WAX (WT %): 5.5(LYNCH 81)

11.5 ASPHALTENES (WT %): 1.45(LYNCH 81),(IP METHOD 143/57)

STANDARD ASSAY DATA - LA ROSA CRUDE OIL
PAGE 1

1.0 TYPE: LA ROSA CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 25.3(NELSON 69)

4.0 DENSITY (g/ml):

		WEATHERING (%)	
TEMP (DEG C)	0	..	..
0	0.923(MACKAY 82A)		
5	0.921(MACKAY 82A)		
10	0.917(MACKAY 82A)		
15	0.914(MACKAY 82A)		
20	0.911(MACKAY 82A)		
25	0.908(MACKAY 82A)		

NOTE: DEN = 0.923 - 0.000617 T
WHERE: DEN IS THE DENSITY OF FRESH OIL AT T (g/ml)
T IS OIL TEMPERATURE (DEG C)(MACKAY 82A)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	640(MACKAY 82A)		
5	423(MACKAY 82A)		
10	282(MACKAY 82A)		
15	180(MACKAY 82A)		
20	135(MACKAY 82A)		
25	104(MACKAY 82A)		

NOTE: $\mathrm{VISC} = \exp((6040/(T+273)) - 15.7)$
WHERE: VISC IS THE VISCOSITY OF FRESH OIL AT T (mPa.s)
T IS OIL TEMPERATURE (DEG C) (MACKAY 82A)

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	693(MACKAY 82A)		
5	459(MACKAY 82A)		
10	308(MACKAY 82A)		
15	197(MACKAY 82A)		
20	148(MACKAY 82A)		
25	115(MACKAY 82A)		

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -30(MACKAY 82A)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 PARAFFINS (WT %): 66.1(MACKAY 82A)

11.2 AROMATICS (WT %): 23.2(MACKAY 82A)

11.3 WAX (WT %): 9.90(MACKAY 82A)

11.4 ASPHALTENES (WT %): 6.23(MACKAY 82A)

11.5 SULPHUR (WT %): 1.76(NELSON 69)

STANDARD ASSAY DATA - LLOYDMINSTER CRUDE OIL

1.0 TYPE: LLOYDMINSTER CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 16.2(NELSON 69)

4.0 DENSITY (g/ml):

TEMP (DEG C)	WEATHERING (WT %) 0	10	20
0	0.910 (MACKAY 82A)		
5	0.908 (MACKAY 82A)		
10	0.906 (MACKAY 82A)		
15	0.902 (MACKAY 82A)		
20	0.900 (MACKAY 82A)	0.923 (MACKAY 82A)	0.937 (MACKAY 82A)
25	0.897 (MACKAY 82A)		

NOTES: 0.90 @ ROOM TEMP (TWARDUS 80)

DEN = 0.910 - 0.00053 T
WHERE: DEN IS DENSITY OF FRESH OIL AT T (g/ml)
T IS OIL TEMPERATURE (DEG C) (MACKAY 82A)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	180(MACKAY 82A) 126(TWARDUS 80)		
5	113(MACKAY 82A)		
10	80.1(MACKAY 82A) 86.1(TWARDUS 80)		
15	62.7(MACKAY 82A)		
20	47.6(MACKAY 82A) 52.3(TWARDUS 80)		
25	35.6(MACKAY 82A)		

NOTES: VISC = EXP((5100/(T+273)) - 13.6)
WHERE: VISC IS THE VISCOSITY OF FRESH OIL AT T (mPa.s)
EXP IS EXPONENTIAL BASE e
T IS OIL TEMPERATURE (DEG C)

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (%) 0	..	..
0	198(MACKAY 82A)		
5	124(MACKAY 82A)		
10	88.4(MACKAY 82A)		
15	69.5(MACKAY 82A)		
20	52.9(MACKAY 82A)		
25	39.7(MACKAY 82A)		

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm): 25 @ ROOM TEMP (TWARDUS 80)

6.2 OIL-WATER (mN/m or dynes/cm): 31.2 @ ROOM TEMP (TWARDUS 80)

7.0 POUR POINT (DEG C):

WEATHERING (WT %)	POUR POINT (DEG C)
0	-36 (MACKAY 82A) -52 (TWARDUS 80)
10	-36 (MACKAY 82A)
20	-21 (MACKAY 82A)

8.0 FLASH POINT (DEG C): 11 (O.C.) (TWARDUS 80)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
0	40 (TWARDUS 80)
10	110 (TWARDUS 80)
20	190 (TWARDUS 80)
30	760 (TWARDUS 80)
40	290 (TWARDUS 80)
50	335 (TWARDUS 80)
60	345 (TWARDUS 80)
70	356 (TWARDUS 80)
80	371 (TWARDUS 80)
90	380 (TWARDUS 80)

11.0 OTHERS:

11.1 IN-SITY COMBUSTION OF FRESH OIL: EASILY IGNITED, 6.1 VOL% RESIDUE(TWARDUS 80)

11.2 FIRE POINT (DEG C): 17(TWARDUS 80)

11.3 PARAFFINS (WT %):

WEATHERING (WT %)	PARAFFINS (WT %)
0	68.4(MACKAY 82A)
10	66.0(MACKAY 82A)
20	62.7(MACKAY 82A)

11.4 AROMATICS (WT %):

WEATHERING (WT %)	AROMATICS (WT %)
0	22.3(MACKAY 82A)
10	22.2(MACKAY 82A)
20	24.0(MACKAY 82A)

11.5 WAX (WT %):

WEATHERING (WT %)	WAX (WT %)
0	5.47(MACKAY 82A)
10	9.36(MACKAY 82A)
20	11.1(MACKAY 82A)

11.6 ASPHALTENES (WT %):

WEATHERING (WT %)	ASPHALTENES (WT %)
0	5.58(MACKAY 82A)
10	8.68(MACKAY 82A)
20	9.87(MACKAY 82A)

STANDARD ASSAY DATA - LLOYDMINSTER CRUDE OIL 2

1.0 TYPE: LLOYDMINSTER CRUDE OIL, ALBERTA AND SASKATCHEWAN
TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 20.7(AALUND 83A)

4.0 DENSITY (g/ml): @ 21 DEG C, 0.9289(AALUND 83A)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt): @ 40 DEG C,
101.00(AALUND 83A)

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -32.0(AALUND 83A)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa): 30.3(AALUND 83A)

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 SULFUR (PPM): 31,500(AALUND 83A)

11.2 CON. CARBON (WT %): 9.18(AALUND 83A)

11.3 METALS (PPM): NICKEL: 52.70(AALUND 83A)
VANADIUM: 10.50(AALUND 83A)

STANDARD ASSAY DATA - MAYOGIAK CRUDE OIL

1.0 TYPE: MAYOGIAK CRUDE OIL, BEAUFORT SEA. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml):

TEMP (DEG C)	WEATHERING (%) 0	4	12
20	0.8625 (ENGELHARDT 84)	0.8727 (ENGELHARDT 84)	0.8848 (ENGELHARDT 84)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (%) 0	4	12
-10	752.1 (ENGELHARDT 84)	1023 (ENGELHARDT 84)	D.F. (ENGELHARDT 84)
0	67.27 (ENGELHARDT 84)	98.35 (ENGELHARDT 84)	414.3 (ENGELHARDT 84)
15	17.04 (ENGELHARDT 84)	29.88 (ENGELHARDT 84)	56.37 (ENGELHARDT 84)
25	9.702 (ENGELHARDT 84)	18.33 (ENGELHARDT 84)	30.41 (ENGELHARDT 84)

NOTE: D.F.- DIDNOT FLOW

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C):

WEATHERING (%)	POUR POINT (DEG C)
0	-30(ENGELHARDT 84)
4	-26(ENGELHARDT 84)
12	-18(ENGELHARDT 84)

STANDARD ASSAY DATA - MAYOGIAK CRUDE OIL

8.0 FLASH POINT (DEG C):

WEATHERING (%)	FLASH POINT (DEG C)
0	-12 (ENGELHARDT 84)
4	47 (ENGELHARDT 84)
12	66 (ENGELHARDT 84)

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA (DEG C):

PERCENT CONDENSED (VOL %)	WEATHERING (%)		
	0	4	12
INITIAL	-2 (ENGELHARDT 84)	55 (ENGELHARDT 84)	146 (ENGELHARDT 84)
50	318 (ENGELHARDT 84)	336 (ENGELHARDT 84)	376 (ENGELHARDT 84)
FINAL	555 (ENGELHARDT 84)	554 (ENGELHARDT 84)	558 (ENGELHARDT 84)
FINAL VOL CONT'D	94 % (ENGELHARDT 84)	88 % (ENGELHARDT 84)	83 % (ENGELHARDT 84)

11.0 OTHERS:

11.1 FIRE POINT:

WEATHERING (%)	FIRE POINT (DEG C)
0	-12 (ENGELHARDT 84)
4	64 (ENGELHARDT 84)
12	76 (ENGELHARDT 84)

STANDARD ASSAY DATA - MURBAN CRUDE OIL
PAGE 1

1.0 TYPE: MURBAN CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml):

TEMP (DEG C)	WEATHERING (WT %) 0	10	20
0	0.838 (MACKAY 82A)		
5	0.832 (MACKAY 82A)		
10	0.830 (MACKAY 82A)		
15	0.828 (MACKAY 82A)		
20	0.824 (MACKAY 82A)	0.842 (MACKAY 82A)	0.855 (MACKAY 82A)
25	0.822 (MACKAY 82A)		

NOTES: DEN = 0.837 - 0.000606 T
WHERE: DEN IS OIL DENSITY OF AT T (g/ml)
T IS OIL TEMPERATURE (DEG C) (MACKAY 82A)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	40.1(MACKAY 82A)		
5	22.1(MACKAY 82A)		
10	11.9(MACKAY 82A)		
15	6.97(MACKAY 82A)		
20	4.37(MACKAY 82A)		
25	3.90(MACKAY 82A)		

NOTES: VISC = EXP((7960/(T+273)) - 25.6)
WHERE: VISC IS THE VISCOSITY OF FRESH OIL AT T (mPa.s)
EXP IS EXPONENTIAL BASE e
T IS OIL TEMPERATURE (DEG C) (MACKAY 82A)

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
0	47.9(MACKAY 82A)		
5	26.6(MACKAY 82A)		
10	14.3(MACKAY 82A)		
15	8.42(MACKAY 82A)		
20	5.30(MACKAY 82A)		
25	4.74(MACKAY 82A)		

6.0 INTERFACIAL TENSIONS:

6.1 OIL-SEAWATER (mN/m or dynes/cm): @ ? TEMP: 16.3;
16.4 @ 10 WT % WEATHERING;
14.3 @ 20 WT % WEATHERING(MACKAY 82A)

STANDARD ASSAY DATA - MURBAN CRUDE OIL

7.0 POUR POINT (DEG C):

WEATHERING (WT %)	POUR POINT (DEG C)
0	-3(MACKAY 82A)
10	0(MACKAY 82A)
20	15(MACKAY 82A)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 PARAFFINS (WT%):

WEATHERING (WT %)	PARAFFINS (WT %)
0	81.4(MACKAY 82A)
10	76.3(MACKAY 82A)
20	74.3(MACKAY 82A)

11.2 AROMATICS (WT %):

WEATHERING (WT %)	AROMATICS (WT %)
0	16.6(MACKAY 82A)
10	17.5(MACKAY 82A)
20	19.4(MACKAY 82A)

11.3 WAX (WT %):

WEATHERING (WT %)	WAX (WT %)
0	5.68(MACKAY 82A)
10	6.83(MACKAY 82A)
20	7.45(MACKAY 82A)

11.4 ASPHALTENES (WT %):

WEATHERING (WT %)	ASPHALTENES (WT %)
0	0.75(MACKAY 82A)
10	4.14(MACKAY 82A)
20	4.20(MACKAY 82A)

11.5 AQUEOUS SOLUBILITY (mg/L): @ ROOM TEMP, 28.62
(BOBRA 83)

STANDARD ASSAY DATA - NEKTORALIK K-59 CRUDE OIL

1.0 TYPE: NEKTORALIK K-59 CRUDE OIL, BEAUFORT SEA.
TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 26.1(DOME 84)

4.0 DENSITY (g/ml): @ 15.6 DEG C, 0.8541(DOME 84)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%)		
	0	..	..
10	21(DOME 84)		
20	12.90(DOME 84)		
30	9.80(DOME 84)		
40	6.78(DOME 84)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): 2.8(DOME 84)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

STANDARD ASSAY DATA - NEKTORALIK K-59 CRUDE OIL
PAGE 2

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
5	121(DOME 84)
10	160(DOME 84)
15	198(DOME 84)
20	238(DOME 84)
25	254(DOME 84)
30	277(DOME 84)
35	287(DOME 84)
40	298(DOME 84)
45	304(DOME 84)
50	312(DOME 84)
55	321(DOME 84)
60	338(DOME 84)
65	342(DOME 84)
70	343(DOME 84)

11.0 OTHERS:

11.1 TOTAL SULFUR (WT %): 0.17(DOME 84)

11.2 TOTAL SALTS (g/m^3): 0.5992(DOME 84)

STANDARD ASSAY DATA - NEKTORALIK K-59A CRUDE OIL
PAGE 1

1.0 TYPE: NEKTORALIK K-59A CRUDE OIL, BEAUFORT SEA.
TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 39.9(DOME 84)

4.0 DENSITY (g/ml): @ ? TEMP, 0.8257(DOME 84)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

		WEATHERING (%)	
TEMP (DEG C)	0	..	..
20	1.396(DOME 84)		
30	1.205(DOME 84)		
40	1.020(DOME 84)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

		WEATHERING (%)	
TEMP (DEG C)	0	..	..
20	1.695(DOME 84)		
30	1.475(DOME 84)		
40	1.260(DOME 84)		

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -39(DOME 84)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
5	90(DOME 84)
10	101(DOME 84)
15	111(DOME 84)
20	120(DOME 84)
25	131(DOME 84)
30	140(DOME 84)
35	153(DOME 84)
40	170(DOME 84)
45	186(DOME 84)
50	201(DOME 84)
55	217(DOME 84)
60	231(DOME 84)
65	243(DOME 84)
70	254(DOME 84)
75	267(DOME 84)
80	280(DOME 84)
85	294(DOME 84)
90	313(DOME 84)
95	323(DOME 84)

11.0 OTHERS:

11.1 TOTAL SULFUR (WT %): 0.0067(DOME 84)

11.2 TOTAL SALTS (g/m^3): 32.075(DOME 84)

STANDARD ASSAY DATA - NERLERK M-98A CRUDE OIL
PAGE 1

1.0 TYPE: NERLERK M-98 CRUDE OIL, BEAUFORT SEA.
TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 22.3(DOME 84)

4.0 DENSITY (g/ml): @ 15.6 DEG C, 0.9227(DOME 84)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	0	WEATHERING (%) ..	..
20	89.6(DOME 84)		
30	50.3(DOME 84)		
40	30.0(DOME 84)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C):

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

STANDARD ASSAY DATA - NERLERK M-98B CRUDE OIL

1.0 TYPE: NERLERK M-98B CRUDE OIL, BEAUFORT SEA.
TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 24.3(DOME 84)

4.0 DENSITY (g/ml): @ 15.6 DEG C, 0.9114(DOME 84)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

TEMP (DEG C)	WEATHERING (%) 0	..	..
20	54.3(DOME 84)		
30	30.6(DOME 84)		
40	19.4(DOME 84)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C):

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

STANDARD ASSAY DATA - NERLERK M-98C CRUDE OIL
PAGE 1

1.0 TYPE: NERLERK M-98C CRUDE OIL, BEAUFORT SEA.
TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 26.4(DOME 84)

4.0 DENSITY (g/ml): @ 15.6 DEG C, 0.8981(DOME 84)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

		WEATHERING (%)	
TEMP (DEG C)	0	..	..
20	12.7(DOME 84)		
30	8.84(DOME 84)		
40	6.34(DOME 84)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C):

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

1.0 TYPE: NINIAN CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 37.0(LYNCH 81)

4.0 DENSITY (g/ml): @ 16 DEG C, 0.8393(LYNCH 81)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt): @ 50 DEG C, 7.5 (LYNCH 81)

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): 6(LYNCH 81)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

WEIGHT PERCENT	TEMP (DEG C)
6.7	5 TO 100(LYNCH 81)
12.7	100 TO 160(LYNCH 81)
12.1	160 TO 250(LYNCH 81)
19.7	250 TO 350(LYNCH 81)
48.8	>350(LYNCH 81)

11.0 OTHERS:

11.1 WAX (WT %): 8(LYNCH 81)

11.2 ASPHALTENES (WT %): 0.5(LYNCH 81),(IP METHOD 143/57)

STANDARD ASSAY DATA - NORTH SLOPE CRUDE OIL
PAGE 1

1.0 TYPE: NORTH SLOPE CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 26.8(API 81)

4.0 DENSITY (g/ml): @ 15.5 DEG C, 0.893(API 81)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C):

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
5	98(API 81)
10	131(API 81)
15	161(API 81)
20	193(API 81)
25	216(API 81)
30	241(API 81)
35	262(API 81)
40	282(API 81)
45	301(API 81)
50	323(API 81)
55	342(API 81)
60	361(API 81)
65	380(API 81)
70	400(API 81)
75	419(API 81)
80	439(API 81)
85	461(API 81)
90	484(API 81)
95	511(API 81)
FBP	539(API 81)

NOTE: (API 81) DATA FROM SIMULATED DISTILLATION ASTM METHOD D 2887

11.0 OTHERS:

11.1 SULFUR (WT %): 1.04(API 81)

11.2 NITROGEN (WT %): 0.20(API 81)

11.3 METALS (PPM): NICKEL: 21(API 81)
VANADIUM: 9.4 TO 9.7(API 81)

STANDARD ASSAY DATA - PIPER CRUDE OIL

1.0 TYPE: PIPER CRUDE OIL, NORTH SEA. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 35.2(HMSO 76)

4.0 DENSITY (g/ml): @ 15 DEG C, 0.849(HMSO 76)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt): @ 50 DEG C, 3.55(HMSO 76)

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -9 (-3)(HMSO 76)

NOTE: FIGURES IN BRACKETS ARE OBTAINED FROM THE OIL INDUSTRY AND ARE THOSE WHICH DONOT AGREE WITH THE PUBLISHED DATA (HMSO 76)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

WEIGHT PERCENT	TEMP (DEG C)
8.4,(8.3)	5 TO 100(HMSO 76)
17.6,(12.1)	100 TO 160(HMSO 76)
11.9,(12.9)	160 TO 250(HMSO 76)
17.9,(18.7)	250 TO 350(HMSO 76)
44.2,(48)	>350(HMSO 76)

NOTE: FIGURES IN BRACKETS ARE OBTAINED FROM THE OIL INDUSTRY AND ARE THOSE WHICH DONOT AGREE WITH THE PUPLISHED DATA.(HMSO 76)

11.0 OTHERS:

11.1 SULFUR (WT %): 0.92(HMSO 76)

11.2 WAX (WT %): 4(HMSO 76)

STANDARD ASSAY DATA - RAINBOW L & M CRUDE OIL
PAGE 1

1.0 TYPE: RAINBOW LIGHT & MEDIUM CRUDE OIL, ALBERTA.
TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 40.7(AALUND 83A)

4.0 DENSITY (g/ml): @ 21 DEG C, 0.8210(AALUND 83A)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt): @ 40 DEG C,
3.77(AALUND 83A)

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): 2.5(AALUND 83A)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa): 33.9(AALUND 83A)

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 SULFUR (PPM): 5,000(AALUND 83A)

11.2 CON. CARBON (WT %): 1.65(AALUND 83A)

11.3 METALS (PPM): NICKEL: 0.85(AALUND 83A)
VANADIUM: 0.50(AALUND 83A)

11.4 H2S (PPM): 10.2(AALUND 83A)

11.5 WAX (WT %): 20.40(AALUND 83A)

STANDARD ASSAY DATA - RANGELAND-SOUTH L & M CRUDE OIL

1.0 TYPE: RANGELAND-SOUTH L & M CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 39.5(AALUND 83A)

4.0 DENSITY (g/ml): @ 21 DEG C, 0.8267(AALUND 83A)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt): @ 40 DEG C,
2.67(AALUND 83A)

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -40(AALUND 83A)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa): 39.3(AALUND 83A)

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 SULFUR (PPM): 7,520(AALUND 83A)

11.2 CON. CARBON (WT %): 0.69(AALUND 83A)

11.3 METALS (PPM): NICKEL: 1.20(AALUND 83A)
VANADIUM: 1.40(AALUND 83A)

11.4 H2S (PPM): 20.1(AALUND 83A)

11.5 WAX (WT %): 12.44(AALUND 83A)

STANDARD ASSAY DATA - SOUTH LOUISIANA CRUDE OIL

1.0 TYPE: SOUTH LOUISIANA CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 37.0(API 81), 34.5(PANCIROV 74)

4.0 DENSITY (g/ml): @ 15.6 DEG C, 0.839(API 81)

5.0 VISCOSITY:

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C):

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
5	76(API 81)
10	105(API 81)
15	132(API 81)
20	156(API 81)
25	178(API 81)
30	203(API 81)
35	221(API 81)
40	239(API 81)
45	254(API 81)
50	271(API 81)
55	284(API 81
60	302(API 81)
65	321(API 81)
70	341(API 81)
75	362(API 81)
80	384(API 81)
85	411(API 81)
90	440(API 81)
95	468(API 81)
FBP	530(API 81)

NOTE: (API 81) DATA FROM SIMULATED DISTILLATION ASTM METHOD D 2887

11.0 OTHERS:

11.1 SULFUR (WT %): 0.21(API 81), 0.25(PANCIROV 74)

11.2 NITROGEN (WT %): 0.031(API 81), 0.069(PANCIROV 74)

11.3 METALS (PPM): NICKEL: 1.1(API 81), 2.2(PANCIROV 74)
VANADIUM: 0.9(API 81), 1.9(PANCIROV 74)

STANDARD ASSAY DATA - TARSIUT A-25 CRUDE OIL

1.0 TYPE: TARSIUT A-25 CRUDE OIL, BEAUFORT SEA.
TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 30.8(DOME 84)

4.0 DENSITY (g/ml): @ 21 DEG C, 0.8711(DOME 84)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

		WEATHERING (%)	
TEMP (DEG C)	0	..	..
20	5.432(DOME 84)		
30	4.117(DOME 84)		
40	3.155(DOME 84)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -31.9(DOME 84)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

STANDARD ASSAY DATA - TYPICAL HEATING OIL
PAGE 1

1.0 TYPE: TYPICAL HEATING OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 32.1(API 81)

4.0 DENSITY (g/ml): @ 15.6 DEG C, 0.8641(API 81)

5.0 VISCOSITY:

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C):

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

STANDARD ASSAY DATA - TYPICAL HEATING OIL

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
IBP	116(API 81)
5	171(API 81)
10	194(API 81)
15	207(API 81)
20	216(API 81)
25	226(API 81)
30	233(API 81)
35	243(API 81)
40	251(API 81)
45	258(API 81)
50	267(API 81)
55	273(API 81)
60	280(API 81)
65	287(API 81)
70	297(API 81)
75	306(API 81)
80	317(API 81)
85	327(API 81)
90	339(API 81)
95	356(API 81)
FBP	399(API 81)

NOTE: (API 81) DATA FROM SIMULATED DISTILLATION ASTM METHOD D 2887

11.0 OTHERS:

11.1 SULFUR (WT %): 0.19(API 81)

11.2 NITROGEN (WT %): 0.014(API 81)

11.3 METALS (PPM): NICKEL: <0.1 TO 0.1(API 84)
VANADIUM: 0.1 TO 0.2(API 81)

STANDARD ASSAY DATA - UKALERK 2C-50 CRUDE OIL

1.0 TYPE: UKALERK 2C-50 CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 45.7(DOME 84)

4.0 DENSITY (g/ml): @ 21 DEG C, 0.7978(DOME 84)

5.0 VISCOSITY:

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): 1.7(DOME 84)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

STANDARD ASSAY DATA - WAINWRIGHT-KINSELLA CRUDE OIL
PAGE 1

1.0 TYPE: WAINWRIGHT-KINSELLA CRUDE OIL, ALBERTA.
TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY: 23.1(AALUND 83A)

4.0 DENSITY (g/ml): @ 21 DEG C, 0.9145(AALUND 83A)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt): @ 40 DEG C,
32.50(AALUND 83A)

6.0 INTERFACIAL TENSIONS:

7.0 POUR POINT (DEG C): -39.0(AALUND 83A)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa): 30.3(AALUND 83A)

10.0 ASTM DISTILLATION DATA:

11.0 OTHERS:

11.1 SULFUR (PPM): 15,800(AALUND 83A)

11.2 CON. CARBON (WT %): 6.70(AALUND 83A)

11.3 METALS (PPM): NICKEL: 40.30(AALUND 83A)
VANADIUM: 79.90(AALUND 83A)

STANDARD ASSAY DATA - WEYBURN-MIDALE CRUDE OIL

PAGE 1

1.0 TYPE: WEYBURN-MIDALE CRUDE OIL. TYPICAL DATA.

2.0 COLOUR:

3.0 API GRAVITY:

4.0 DENSITY (g/ml): @ ROOM TEMP: 0.89(TWARDUS 80)

5.0 VISCOSITY:

5.1 DYNAMIC VISCOSITY (mPa.s or cp):

	WEATHERING (%)		
TEMP (DEG C)	0	..	..
0	88(TWARDUS 80)		
10	29(TWARDUS 80)		
20	18(TWARDUS 80)		

5.2 KINEMATIC VISCOSITY (mm^2/sec or cSt):

6.0 INTERFACIAL TENSIONS:

6.1 AIR-OIL (mN/m or dynes/cm): @ ROOM TEMP: 24.1 (TWARDUS 80)

6.2 OIL-WATER (mN/m or dynes/cm): @ ROOM TEMP: 29.7 (TWARDUS 80)

7.0 POUR POINT (DEG C): -28(TWARDUS 80)

8.0 FLASH POINT (DEG C):

9.0 VAPOUR PRESSURE (kPa):

10.0 ASTM DISTILLATION DATA:

VOLUME PERCENT	TEMP (DEG C)
0	45(TWARDUS 80)
10	90(TWARDUS 80)
20	130(TWARDUS 80)
30	190(TWARDUS 80)
40	230(TWARDUS 80)
50	265(TWARDUS 80)
60	275(TWARDUS 80)
70	335(TWARDUS 80)
80	385(TWARDUS 80)

11.0 OTHERS:

11.1 IN-SITU COMBUSTION OF FRESH OIL: EASILY IGNITED, 7.4 VOL % RESIDUE (TWARDUS 80)

11.2 FIRE POINT (DEG C): <14(TWARDUS 80)

APPENDIX A: Detailed Experimental Procedures

1.0 Density
2.0 Viscosity (Zeitfuchs Cross-arm)
3.0 Viscosity (Brookfield)
4.0 Interfacial Tensions
5.0 Pour Point
6.0 Flash Point
7.0 Reid Vapour Pressure
8.0 ASTM Distillation
9.0 Water-in-Oil Emulsion
10.0 Gas Stripping
11.0 Chemical Dispersibility

Note: These are the procedures being followed at Environmental Emergencies Technology Division, Environment Canada, and are referred to as (EETD 84) in the data sections.

APPENDIX A

1.0 PROCEDURE FOR DENSITY DETERMINATION

1.1 Introduction

The density of crude oils and oil products is determined at a specified test temperature using 10 ml pycnometers. This procedure is similar to ASTM D 1480.

1.2 Procedure

- Wash pycnometer with soap and water. Dry with acetone and air.

- Weigh the empty pycnometer (avoid putting fingerprints on the pycnometer.)

- Add crude oil to pycnometer using an eyedropper.

- Use parafilm to seal the pycnometer opening.

- Store pycnometer and stopper at test temperature.

- When oil and pycnometer are at the test temperature, remove parafilm, adjust oil level to about the middle of the ground joint and place the stopper on the pycnometer (use tissue to absorb any overflowing oil).

- Use tissue to wipe clean the outside of the pycnometer (in the temperature control room) and weigh the pycnometer immediately.

- Remove stopper, pour oil out and rinse pycnometer and stopper with methylene chloride immediately after weighing.

1.3 Calculations

To calculate density:

$$\text{density} = \frac{\text{weight of oil}}{\text{vol of pycnometer at test temp}}$$

APPENDIX A

2.0 PROCEDURE FOR VISCOSITY DETERMINATION USING ZEITFUCHS CROSS-ARM VISCOMETER

2.1 Introduction

The kinematic viscosity of crude oils and oil products is determined (assuming a Newtonian fluid) by measuring the time required for a known volume of oil to flow under gravity through a calibrated Zeitfuchs Cross-arm capillary viscometer at a specified temperature. This procedure is similar to ASTM D 445.

2.2 Procedure

- Estimate viscosity of oil sample and select calibrated Zeitfuchs Cross-arm viscometer with suitable viscosity range.

- Rinse viscometer with methylene chloride and let dry.

- Add oil sample to mark on the neck of viscometer.

- Place parafilm on both openings of viscometer.

- Place viscometer in 500 ml graduated cylinder filled with water (kept at test temperature).

- Oil sample should be more than 20 mm below water surface and the bottom of the viscometer should be more than 20 mm above the bottom of the graduated cylinder.

- Allow oil sample to reach the test temperature.

- Use pressure to force oil to start flowing down the vertical section of the viscometer.

- Measure flow time in seconds for the oil meniscus to pass from the first timing mark to the second timing mark.

- Flow time should be within 200 to 1000 seconds. Otherwise, calculate approximate viscosity and choose another viscometer to repeat the experiment.

- Clean viscometer with methylene chloride and repeat experiment at the same conditions (using the same viscometer).

2.0 PROCEDURE FOR VISCOSITY DETERMINATION USING ZEITFUCHS CROSS-ARM VISCOMETER (Cont'd)

- Periodically, inspect the viscometer and remove any deposits from the inside.

2.3 Calculations

To calculate kinematic viscosity, average the flow times from the two runs and obtain calibration constant of the viscometer:

Kinematic Viscosity (mm sq/s or cSt)	=	Average Flow Time (s)	*	Calibration Constant (mm sq/s sq or cSt/s)

To calculate dynamic vicosity:

Dynamic Viscosity (mPa.s or cp)	=	Kinematic Viscosity (mm sq/s or cSt)	*	Density (g/ml)

APPENDIX A

3.0 PROCEDURE FOR VISCOSITY DETERMINATION USING BROOKFIELD VISCOMETER

3.1 Introduction

The viscosity of non-Newtonian crude oils and oil products can be measured by a Brookfield viscometer. By rotating a spindle in a sample at a constant rate, the torque required to maintain a constant spindle rotation is displayed on the viscometer dial.This reading can be converted into dynamic viscosity.

3.2 Procedure

- Estimate viscosity of oil sample and select appropriate spindle.

- Rinse spindle and small sample holder with methylene chloride and let dry.

- Insert spindle inside sample holder. Use transfer pipette to add oil SLOWLY to the sample holder and place parafilm on sample holder opening.

- Allow sample, sample holder and spindle to come to test temperature in temperature control room.

- Insert sample holder to the sample holder jacket (from the bottom) and lock sample holder in place.

- Attach extension link to spindle.

- Lift shaft of viscometer slightly and thread coupling nut into place CAREFULLY. Do not move shaft sideways.

- Depress clutch and turn on viscometer. Release clutch. The rpm should be at 0.3. Turn speed to 0.3 rpm if required (when the spindle is rotating).

- Wait for spindle to rotate twice and note dial reading. You may have to depress cluch.

- If dial reading is below 10, turn rpm one step higher (when the spindle is turning). Wait for spindle to rotate twice and note dial reading.

APPENDIX A

3.0 PROCEDURE FOR VISCOSITY DETERMINATION USING BROOKFIELD VISCOMETER (Cont'd)

- Increase rpm one more step if dial reading is still below 10. Otherwise, record dial reading and rpm. Turn off viscometer.

- Lift shaft of viscometer slightly and unthread coupling nut.

- Remove extension link. Put parafilm on sample holder. Store sample at test temperature for a few hours. Remove parafilm and repeat measurement at the same rpm.

- Repeat measurement at this rpm once more.

- Rinse sample holder and spindle with methylene chloride.

3.3 Calculations

Average the last two dial readings. Obtain spindle factors from Brookfield Viscometer manual and calculate:

Dynamic viscosity = dial reading * spindle factor
(cp or mPa.s)

APPENDIX A

4.0 PROCEDURE FOR INTERFACIAL TENSIONS

4.1 Introduction

The interfacial tension for the air-oil, oil-deionized water and oil-artificial seawater interfaces are determined using a Fisher Surface Tensiomat Model 21. The interfacial tensions are used for oil spreading tedency studies. This procedure is similar to ASTM D 56.

4.2 Procedure

4.2.1 Cleaning

Glassware: Wash with detergent and water. Rinse with dilute nitric acid and deionized water.

Platinum-iridium Ring: BE CAREFUL NOT TO BEND ANY PART OF THE RING. Rinse with methylene chloride and dry in fume hood.

4.2.2 Air-oil Interfacial Tension

- Keep oil sample and 100 ml beakers at test temperature for two to three hours.

- Pour about 40 ml oil into beaker and immerse ring into oil sample.

- Place beaker on platform of Tensiomat and attach ring to hook of Tensiomat.

- Adjust ring with knob on the right hand side of the tensiometer and adjust level of platform until the torsion arm is horizontal (using the mirror) and the ring is about 4 mm below the oil surface.

- Turn the knob on the front of the tensiometer until the vernier reads zero on the OUTER scale.

- Turn the knob on the right side of the tensiometer and lower the platform at the same time while keeping the torsion arm horizontal until the ring breaks from the interface.

- Record APPARENT surface tension.

- Oil sample is saved for the next section of the experiment (interfacial tension).

4.0 PROCEDURE FOR INTERFACIAL TENSION (Cont'd)

4.2.3 Oil-deionized water Interfacial Tension

- Keep oil, deionized water and 100 ml beaker at test temperature for two to three hours.

- Pour 40 ml of deionized water into beaker and place ring into deionized water.

- Put beaker on platform of Tensiomat. Arrest torsion arm and hook ring on the torsion arm.

- Tilt beaker and add about 30 ml of oil (which should be at the test temperature) slowly and carefully. Make sure the cross bar of the ring is above the oil surface and the ring is underneath the oil-water interface.

- Allow the interface to age for about 30 seconds.

- Adjust with knob on the right hand side of the tensiometer and adjust platform level until the torsion arm is horizontal and the ring is about 4 mm below the oil-water interface.

- Turn the knob on the front of the Tensiomat until the vernier reads zero on the OUTER scale.

- Turn the knob on the left side of the Tensiomat and lower the platform at the same time while keeping the torsion arm horizontal until the ring breaks from the interface. This should take about 30 seconds.

- Record APPARENT interfacial tension.

4.2.4 Oil-artificial seawater Interfacial Tension

Procedure is similar to the procedure for oil-deionized water interfacial tensions. Use filtered artificial seawater (40 g/l of Marinemix in deionized water) instead of deionized water.

4.0 PROCEDURE FOR INTERFACIAL TENSIONS (Cont'd)

4.3 Calculations

Calculate:

$$X = P/(D-d)$$

where: P = apparent interfacial tension (dynes/cm)
D = density of the lower phase (g/ml)
d = density of upper phase (g/ml)

Obtain correction factor for a given X from correction factor versus X curve.

Calculate absolute interfacial tension:

Absolute surface tension (dynes/cm or mN/m)	=	Apparent surface tension (dynes/cm or mN/m)	*	Correction factor

Density of water is 1.0 and 0.999 g/ml at 0 and 15 deg C, respectively (Chemical Engineers' Handbook, Perry, 1973). Density of air at room temperature is about 0.001 g/ml (Flow of Fluids, Crane, 1976).

APPENDIX A

5.0 PROCEDURE FOR POUR POINT DETERMINATION

5.1 Introduction

Pour point is the lowest temperature, expressed as multiples of 3 deg C at which the oil sample is observed to flow when cooled and examined under prescribed conditions. This procedure is modified from ASTM D 97.

5.2 Procedure

5.2.1 Oil Sample Preparation

- Shake oil sample two to three times or until the sample is uniform. If oil is not fluid, heat oil in water bath until oil is very fluid.

- Pour oil into test jar until the level mark is reached.

- Make sure high pour point thermometer does not have a separated mercury column.

- Clean thermometer and fit stopper with thermometer tightly on the test jar.

- Adjust thermometer until oil level is about 1 cm above the end of the thermometer bulb, and thermometer should be coaxial with test jar.

- Insert test jar into pour point jacket. Make sure that test jar is vertical and secure. The following procedure will refer to the test jar and jacket conveniently as test jar.

5.2.2 Approximate Pour Point

- Heat test jar containing the oil sample and thermometer in water bath (at 48 deg C) until oil is very fluid. Use temperature bath at a higher temperature as required. Mix oil slightly.

5.0 PROCEDURE FOR POUR POINT DETERMINATION (Cont'd)

- Cool oil at room temperature. Tilt test jar just enough to notice any oil movement. If oil moves, allow oil to cool three deg C and test again. If oil does not move, continue to tilt test jar until test jar is horizontal. If oil moves during this time, allow oil to cool another 3 deg C and repeat. If oil does not move for 5 seconds at a horizontal position, record temperature as approximate pour point and proceed to the next section (this is referred to as a tilt test).

- When oil temperature is below 35 deg C and the oil still moves, continue cooling of the oil sample in the following sequence and perform tilt test every 3 deg C until approximate pour point is reached:

a) cool oil sample to 25 deg C in 15 deg C room
b) cool oil sample to 10 deg C in 0 deg C room
c) cool oil sample to 0 deg C in freezer
   (about -10 deg C)
d) cool oil sample to -34 in dry ice/acetone bath

Note that the low pour point thermometer is required when the oil temperature is below -12 deg C. Report approximate pour point of <-34 deg C if the oil sample still moves at -34 deg C and proceed to the next section.

5.2.3 Pour Point Above 32 Deg C

If the approximate pour point is above 32 deg C, follow the following procedure to determine the pour point:

- Heat oil sample in a test jar (fitted with a high pour point thermometer) in water bath (at 48 deg C) until oil is very fluid. Use temperature bath at a higher temperature as required. Mix oil slightly.

- Cool oil at room temperature until 8 deg C above the approximate pour point. Perform tilt test as in the previous section. Record the oil temperature when the oil sample does not move at a horizontal position for 5 seconds.

5.2.4 Pour Point Between 32 and -34 deg C

If the approximate pour point is between 32 and -34 deg C, follow the following procedure:

5.0 PROCEDURE FOR POUR POINT DETERMINATION (Cont'd)

- Heat oil sample in test jar (fitted with a high pour point thermometer) in water bath (at 48 deg C) until oil sample is very fluid.

- Cool oil sample in the following sequence until 8 deg C above the approximate pour point, and perform tilt test as in the previous section until the oil sample does not move in a horizontal position for 5 seconds:

a) cool oil sample to 35 deg C at room temperature
b) cool oil sample to 25 deg C in 15 deg C room
c) cool oil sample to 10 deg C in 0 deg C room
d) cool oil sample to 0 deg C in freezer (about -10 deg C)
e) cool oil sample to -34 deg C in dry ice/ acetone bath

Note that the low pour point thermometer is required when the oil temperature is below -12 deg C. Report oil temperature of <-34 deg C if oil sample still moves at -34 deg C.

NOTE: In sections 5.2.3 and 5.2.4, do not disturb the oil mass unnecessary. Repeat if thermometer or the oil mass shifted during tilt test.

5.3 Calculation

Add 3 deg C to results from sections 5.2.3 and 5.2.4, and report as pour point ASTM D 97.

APPENDIX A

6.0 PROCEDURE FOR FLASH POINT DETERMINATION

6.1 Introduction

Flash point is the lowest temperature of an oil sample, corrected to 101.3 kPa, at which application of a test flame causes the vapour of the sample to ignite under specific conditions of the test. This procedure is taken from ASTM D 93 for a Pensky-Martens Closed Tester.

6.2 Procedure

6.2.1 Approximate Flash Point

- Rinse sample cup with methylene chloride and let methylene chloride evaporate in the fume hood.

- Mix oil sample until oil is uniform and pour oil into sample cup until the filling mark is reached.

- Cool oil sample and sample cup to about 30 deg C below the estimated flash point.

- Assemble flash point apparatus.

- TURN FUME HOOD OFF.

- Light test flame and adjust flame to 4 mm in diameter (using metal bead on the sample cover).

- Start stirring and turn heater on.

- Adjust heating such that temperature rise is 5 to 6 deg C per minute.

- Lower test flame into the vapour space within about 0.5 seconds, leave test flame in the vapour space for 1.0 second and raise test flame to up position quickly. Repeat at every degree C temperature increase until flashing or 110 deg C (report approximate flash point of 110 deg C).

- The sample is deemed to have flashed when a large flame appears and instantaneously propagates over the surface of the sample. Record the temperature as approximate flash point.

- Turn test flame, heater and stirrer off.

- TURN ON FUME HOOD.

6.0 PROCEDURE FOR FLASH POINT DETERMINATION (Cont'd)

- Dissemble flash point apparatus.

- Take sample cup out of flash point apparatus (the apparatus is hot).

- When oil sample is cooled to about room temperature, pour oil sample into chlorinated solvent waste bottle. Rinse sample cup with methylene chloride and let it evaporate in the fume hood.

6.2.2 FLASH POINT

- Mix oil sample and pour it into the sample cup until the filling mark is reached.

- Cool oil sample and sample cup to about 30 deg C below the approximate flash point.

- Assemble flash point apparatus.

- TURN OFF FUME HOOD.

- Light test flame and adjust flame to 4 mm in diameter.

- Start stirring and turn heater on.

- Adjust heating such that temperature rise is 5 to 6 deg C per minute.

- When oil temperature is within 17 to 28 deg C below the approximate flash point, lower test flame into the vapour space in about 0.5 seconds, leave test flame in the vapour space for 1.0 second and raise test flame to up position quickly. Observe any flame in the vapour space. The sample is deemed to have flashed when a large flame appears and instantaneously propagates over the surface of the sample. Record this temperature as observed flash point and stop experiment.

- If flash point is not observed lower test flame as above at every deg C temperature increase.

- Stop when temperature is above 110 deg C and report observed flash point as >110 deg C.

- Turn off test flame, heater and stirrer.

6.0 PROCEDURE FOR FLASH POINT DETERMINATION (Cont'd)

- TURN ON FUME HOOD.

- Dissemble flash point apparatus.

- Take sample cup out of flash point apparatus (the apparatus is hot).

- When oil sample is cooled to about room temperature, pour oil sample into chlorinated solvent waste bottle. Rinse sample cup with methylene chloride and let it evaporate in the fume hood.

- Record atmospheric pressure.

6.3 Calculations

Calculate flash point (at atmospheric pressure):

$$\text{flash point} = \text{observed flash point} + 0.033\,(760 - P)$$

where P is atmospheric pressure in mm Hg.

APPENDIX A

7.0 PROCEDURE FOR REID VAPOUR PRESSURE DETERMINATION

7.1 Introduction

This procedure covers the determination of Reid vapour pressure according to ASTM D 323.

7.2 Procedure

7.2.1 Preparation of Reid Vapour Pressure Bomb

- Rinse bomb with methylene chloride, and let dry in a fume hood.

- Keep bomb in temperature control room kept at 0 deg C.

7.2.2 Sample Handling and Transferring

- Store oil sample in 0 deg C room for about 2 hours before test. There should be about 700 mL of sample in the one litre sample bottle.

- Put teflon tape on all joints of the bomb.

- Put vapour pressure gauge (15 psi) on bomb.

- Open sample container once. Mix sample a few times and pour crude oil into sample chamber until overflow. Tap chamber to free any air bubbles.

- Attach sample chamber to air chamber.

- Record atmospheric pressure (P).

7.2.3 Reid Vapour Pressure Measurement

- Shake bomb vigorously and immerse the bomb in the 37.8 deg C (100 deg F) water bath. Observe any leaks on all the joints.

- Discard sample and repeat the experiment if leakage is observed.

- Place bomb on rack in the water bath.

7.0 PROCEDURE FOR REID VAPOUR PRESSURE DETERMINATION (Cont'd)

- After 30 minutes, tap the pressure gauge gently and record pressure.

- If the vapour pressure is above 12 psi, use pressure gauge with range of 10 to 26 psi. Similarly, use pressure gauge with range of 0 to 5 psi if the vapour pressure is below 4 psi.

- Every 10 minutes, remove bomb from water bath and shake, replace bomb in the water bath and record pressure until two consecutive readings are identical.

- Attach pressure gauge to a mercury manometer and a compressed air source. Apply pressure to the pressure gauge and the manometer until the pressure gauge reads the same pressure as the recorded pressure above. Record the manometer reading.

7.2.4 Cleaning

- Pour sample into used solvent container.

- Rinse bomb with methylene chloride and let dry in fume hood.

- Rinse pressure gauge several times with methylene chloride and let dry in fume hood.

7.3 Calculations

Calculate correction factor:

$$C = (-0.138 * (P - 0.09)) - 0.86$$

where: C is correction factor in psi
P is atmospheric pressure in psi

Calculate Reid vapour pressure:

$$\underset{(kPa)}{\text{Reid VP}} = (\underset{(psi)}{\text{manometer reading}} + \underset{(psi)}{C}) * 6.895$$

APPENDIX A

8.0 PROCEDURE FOR MODIFIED ASTM DISTILLATION

8.1 Introduction

The experimental procedure is similar to the standard ASTM distillation method (ASTM D 86). The only major difference is that the oil temperature instead of the vapour temperature is monitored. Distillation data are used to provide the weathering rate of crude oil in the environment.

8.2 Procedure

- Add stirring bar and about 15 ml of glass beads to a 500 ml distillation flask.

- Pour 200 ml of crude oil into the distillation flask.

- Assemble distillation equipment, put aluminum foil around distillation equipment and start cooling water flow.

- Make sure tip of the temperature probe is below oil surface during the experiment.

- Turn stirrer on as fast as possible (without oil splashing).

- Start heating slowly. Condensate should run down the condenser in a dropwise fashion.

- Record initial temperature when the first drop of condensate runs down the curve of the condenser receiver.

- Record temperature at every 2 ml of condensate collected. Stop distillation when oil sample starts to foam, or no more condensate can be collected, or when the oil temperature is above 300 deg C.

- Turn off heater and stirrer. Remove heater and wait for equipment to cool.

- Record atmospheric pressure.

- Cleanup when equipment is cool.

8.0 PROCEDURE FOR MODIFIED ASTM DISTILLATION (Cont'd)

8.3 Calculations

8.3.1 Atmospheric Pressure Correction

Calculate correction factor:

$$C = 0.00012\ (760 - P)\ (273 + t)$$

where: P = atmospheric pressure in mm Hg
t = thermometer reading in deg C

Add correction factor to thermometer reading and round off readings after decimal point.

8.3.2 Initial Boiling Point and Slope

Convert volume condensed to volume fraction distilled. Plot corrected boiling temperature versus fraction of oil distilled on linear coordinates. Draw a best fit straight line through the data points. Determine the initial boiling point and slope of the line.

APPENDIX A

9.0 PROCEDURE FOR WATER-IN-OIL EMULSION FORMATION TENDENCY AND STABILITY TEST

9.1 Introduction

This experiment provides information regarding water-in-oil emulsion formation tendency and stability (f initial and f final) for crude oils and oil products by rotating a mixture of oil sample and artificial seawater at 65 rpm in a closed container. The volume of oil, emulsion and water layers are determined by height measurements from which the fraction of oil in the emulsion (f) and water content in the emulsion are calculated. The emulsion formation tendency and stability are based on the measured fractions (f's) (Mackay 1982a).

9.2 Procedure

- Clean 500 ml Fleakers with soap. Rinse Fleakers with tap water, dilute nitric acid, tap water and deionized water.

- Pour about 300 ml of seawater at test temperature into Fleakers. Adjust the seawater height to 9 +/- 0.1 cm at test temperature.

- Add about 30 ml of crude oil at test temperature to Fleaker, and label Fleaker.

- Put plastic sheet on Fleaker mouth and put stopper on. Keep Fleakers at test temperature for 2 to 3 hours.

- Repeat with seven other oil samples.

- Adjust oil height to 1 +/- 0.1 cm.

- Put Fleakers on emulsion apparatus (at test temperature). Rotate Fleakers for one hour at 65 rpm. Keep Fleakers at a vertical position for half an hour and record the following data: total height (oil + emulsion + water); height of oil and emulsion; and height of oil.

- Repeat rotation, rest and reading three times.

- Keep Fleakers at vertical position for 24 hours and record the following: total height; height of oil and emulsion; and height of oil.

APPENDIX A

9.0 PROCEDURE FOR WATER-IN-OIL EMULSION FORMATION TENDENCY AND STABILITY TEST (Cont'd)

9.3 Calculations

9.3.1 To Calculate f initial

Since the cross-sectional area of Fleakers are uniform, the volume of the layers can be calculated based on the height of the layers.

The fraction of oil in the emulsion after one hour of rotation and half an hour of rest (f 1.5) is:

$$f\ 1.5 = \frac{\text{Initial Oil Height} - \text{Oil Height at 1.5 h}}{\text{Initial Oil Height}}$$

Similarly the fraction of oil in the emulsion at 3.0, 4.5, and 6.0 hours can be calculated. The fraction of oil in the emulsion at time zero (f initial) is obtained by plotting f versus time and extrapolating the curve to time zero.

9.3.2 To Calculate f final

The fraction of oil in the stable emulsion after 24 hours of resting is calculated similarly using the height of the oil at that time.

9.3.3 Water Content in Stable Emulsions

The water content in the stable emulsion is:

$$\text{Height of Oil in Emulsion} = \text{Initial Oil Height} - \text{Oil Height}$$

$$\text{Height of Emulsion} = \text{Height of Oil and Emulsion} - \text{Oil Height}$$

$$\text{Fraction of Water in Emulsion} = 1 - \frac{\text{Height of Oil in Emulsion}}{\text{Height of Emulsion}}$$

APPENDIX A

10.0 PROCEDURE FOR ARTIFICIAL WEATHERING OF CRUDE OILS AND OIL PRODUCTS USING GAS STRIPPING

10.1 Introduction

To simulate natural weathering of crude oils and oil products in the environment, an oil sample is stripped by a stream of air at a specified temperature. The air volume, oil weight and volume are monitored. The experimental results can be correlated to the environmental conditions via environmental exposure (Mackay 1983 b).

10.2 Procedure

- Clean gas stripper and pour oil sample to about 980 ml mark. Keep gas stripper at test temperature for 2 to 3 hours.

- Connect compressed air supply to the gas stripper and connect outlet of gas stripper to hydrocarbon absorbers (3M absorbent and activated charcoal).

- Level wet test meter and add de-ionized water to full mark.

- Record temperature, compressed air cylinder pressure, volume and weight of oil sample, air volume of wet test meter.

- Start air flow to the gas stripper. Air flow rate should be as high as possible but without splashing or oil mist carry over from the stripper.

- Stop air flow to the stripper at regular time intervals and record oil weight and volume, and volume of air on the wet test meter.

- Stop gas stripping when desired degree of weathering is achieved.

APPENDIX A

10.0 PROCEDURE FOR ARTIFICIAL WEATHERING OF CRUDE OILS AND OIL PRODUCTS USING GAS STRIPPING (Cont'd)

10.3 Calculations

Volume fraction weathered (Fv):

$$Fv = 1 - \frac{\text{Final Oil Volume}}{\text{Initial Oil Volume}}$$

Similarly for weight fraction weathered (Fw).

11.0 PROCEDURE FOR CHEMICAL DISPERSIBILITY TEST

11.1 Introduction

Comparative chemical dispersibility of crude oils with respect to Corexit 9527 is provided using the Mackay-Nadeau-Steelman (MNS) apparatus (Mackay 1980 b).

11.2 Procedure

- Add 6 liters of artificial seawater (40 g/L of Marinemix in deionized water) to test vessel at test temperature.

- Assemble the MNS apparatus.

- Turn powerstat for the blowers to 85% and wait for a stable wave to form in the test vessel. The wave height should be at least 6 cm. Adjust power to the blowers to the pre-determined level.

- Make sure water and air temperatures are within 1 deg C of test temperature.

- Add 10 ml of oil sample to the inside of the glass containment ring.

- Start stopwatch and add pre-determined amount of Corexit 9527 to the oil sample. Distribute the dispersant evenly on the oil sample.

- At 1.5 minutes, raise the glass containment ring and allow oil sample to disperse. Wave height should not be less than 3 cm. Otherwise, repeat experiment.

- At 11.0 minutes, start siphoning water sample into a waste container.

- At 11.5 minutes, collect 250 ml of sample in a volumetric flask.

- Stop blowers and clean up.

- Repeat experiment at other dispersant addition rate.

APPENDIX A

11.0 PROCEDURE FOR CHEMICAL DISPERSIBILITY TEST (Cont'd)

11.3 Analysis and Calculations

Extract sample with UV grade methylene chloride. Determine absorbance of methylene chloride. Compare absorbance with standards and calculate oil concentration in the sample.

Calculate percent of oil dispersed chemically. Plot percent oil dispersed versus oil to dispersant ratio. Determine oil to dispersant ratio at 50 % dispersion.